GIANT RAGWEED (*Ambrosia trifida*)

COMMON RAGWEED (*Ambrosia artemisiafolia*)

HAYFEVER AND ASTHMA

CARE, PREVENTION AND TREATMENT

BY

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1 COLORED PLATE

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PREFACE.

THE evolution of our knowledge of hayfever, from the chaotic conceptions of a "mysterious disease" to its present scientific development, forms an interesting chapter in the history of this widespread disease.

It was not until 1819 that hayfever first emerged as a distinct disease, and not until 1873 that the etiologic relation of pollens was discovered. As the first investigations were made in England, where the ragweed and wormwood pollens—the chief causes of hayfever in the United States—are not found, our knowledge of the specific hayfever pollens was for many years vague and misleading.

In 1906, after a series of botanical and clinical surveys of the eastern and southern states, the author was able to establish the synchronism of fall hayfever and the pollinating season of the common and giant ragweeds. Subsequently he was able to prove the innocence of the golden rod, the generally accepted cause of fall hayfever, not only because its pollen could not be found in the air, but also because the golden rod continued to bloom after the hayfever season has passed.

With a view of creating public interest in hayfever by explaining the cause of the disease and the means for its prevention, a meeting of public-spirited men in New Orleans was called on August 5, 1915, and the nucleus of the American Hayfever Prevention Association was formed. After having carefully explained the proofs of the relation of pollens to hayfever, a prominent newspaper editor, who was present, was requested to give due publicity to the proceedings as a means of encouraging hayfever prevention; he replied, "Nothing doing, Doctor, we don't take any stock in your new-fangled theories." Such was the humble beginning

of an association, which now has the endorsement of the United States Public Health Service and of practically all of the state boards of health of the United States.

The first step in popular education as to the pollen theory of hayfever was made a few days after the first meeting of the association. A party of men, three of whom were hayfever subjects, but who had not yet developed their annual attacks, were taken to a suburb where the common ragweed had just commenced to bloom. Within five minutes after their arrival, the three hayfever subjects, including a professor of Tulane University, had developed violent attacks, which lasted for several hours. Needless to state that this and similar experiences soon established convincing proofs of the cause of hayfever.

The routine laboratory test in such cases, however, was the application of the staminate flowers, containing the pollen, to the nostrils of the subject to be tested. While the present refined method of diagnosing hayfever is by injecting a few drops of the pollen extracts into the skin of the patient, the nasal test remains as a crude but convincing proof of the relationship of pollen to hayfever.

After the initial work in New Orleans, an attempt was made to disseminate the benefits of weed control for the prevention of hayfever throughout the United States. A letter was addressed to all the state boards of health, explaining the etiologic relation of pollens of weeds to hayfever, and urging coöperation for their control. Only four boards of health responded, the first being that of the state of New York.

This board has consistently supported the efforts of the National Association for the control of hayfever. On one occasion, when we called its attention to the fact that some of the New York nurserymen had introduced the Mexican wormwood for decorative purposes, and that there was danger of this being naturalized and forming a source of a violent form of hayfever, this board promptly ordered the importation of this plant to be discontinued.

Shortly after the first efforts with the state boards of health for the control of hayfever, an appeal was made to

interest the United States Public Health Service, which resulted in the following official endorsement by Dr. Rupert Blue, Surgeon-General of this department.

"It appears that the most practical method of securing the coöperation of the public would be by education as to the effect of the presence of these weeds in communities from both health and economic standpoints. This seems to be the primary object of your association, which is to be commended for its efforts."

Reinforced with this report and the further endorsement that the Surgeon-General accepted the position of honorary vice-president of the Hayfever Association, an appeal was again made to the state boards of health, eventually resulting in practically a unanimous endorsement and promise of coöperation with the efforts of this association.

When the application was made to the California State Board of Health, the president replied that, while hayfever was common in California and he was desirous of coöperating, the common ragweed, which was the special object of our efforts of control, was not found in California. As soon as the incriminating pollen could be determined, the board would willingly assist in our efforts.

When this report was received, the representatives of our botanical department were instructed to forward to our laboratory specimens of all the most common wind-borne pollens. This soon resulted in the discovery that the wormwoods (*Artemisias*) replaced the common ragweeds of the eastern states in being the most common cause of hayfever in the Pacific and Rocky Mountain states, and that the *Ivas* (poverty weed, marsh elder, etc.), *Gætnerias* (sand bur, false ragweed, etc.) and cockle burs formed the principal accessory causes.

An important factor in the etiologic development of hayfever, was our early announcement that only the plants and trees with wind-borne pollens need be considered as a cause of hayfever. The ignorance of this fundamental fact is responsible for the very common errors regarding hayfever pollens in many of our text-books and encyclopedias. This was determined not only botanically, but also by collect-

ing the atmospheric pollens on test plates, and checking their appearance with the clinical symptoms of the disease. In this investigation, our hayfever clinic at the Charity Hospital of New Orleans has been of valuable assistance.

In our researches on hayfever, we are indebted to Parke, Davis & Co., of Detroit, Mich.; H. K. Mulford Co., of Philadelphia; and Eli Lilly & Co., of Indianapolis, for placing their laboratories at our disposal for the preparation of pollen extracts and vaccines used in our experimental and immunizing work.

In our national educational efforts regarding the etiology and prophylaxis of hayfever, we acknowledge the valuable coöperation of the United States Public Health Service in publishing our reports, thus assisting materially in disseminating practical knowledge regarding hayfever. The United States Department of Agriculture has also rendered great assistance, both by actual work and by inducing botanists in various sections of the United States to coöperate with us, by making botanical surveys of their sections, and by collecting and sending pollens for experimental purposes.

All the photomicrographs used in this work are original, and were prepared in our laboratories. The photographs are also original. The line drawings of plants are from the authoritative work *Illustrated Flora of the Northern United States, Canada and the British Possessions*, by Nathaniel Lord Britton and Addison Brown, whose courtesy for their use is hereby acknowledged.

NEW ORLEANS, 1922. W. S.

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HAYFEVER AND ASTHMA.

CHAPTER I.

HISTORY OF HAYFEVER.

HAYFEVER is commonly supposed to be a product of modern civilization, but this is probably incorrect. In the United States the plants that cause hayfever are principally parasites of agriculture, and hayfever has evidently followed the march of agriculture methods.

As hayfever is frequently unsuspected, being still often mistaken for a periodical "cold," the absence of reports of cases of hayfever until the seventeenth century is undoubtedly due to its not being recognized as a specific disease.

The first description of hayfever was given by Bostock,[1] in 1819, who, while ascribing the symptoms to external irritants such as dust, did not suspect the plant pollens. This was first established by Blackley,[2] in 1873, who not only collected the pollens on glycerin plates but also induced attacks of hayfever in patients by the inhalation of the pollen. He also tested the skin reaction of hayfever subjects by means of pollen applied to the scarified skin.

The acceptance of the pollen theory of hayfever made slow progress, and it is only recently that it has been generally accepted. Even at this time, there are physicians who believe that hayfever is a local manifestation of some constitutional disorder, as for instance the so-called "uric-acid

[1] Case of a Periodical Affection of the Eyes and Chest, Med.-Chir. Tr., London, 1819.

[2] Experimental Researches on the Causes and Nature of Catarrhus æstivus, Hayfever or Hay-Asthma, London, 1873.

diathesis," not realizing that this may be only a predisposing factor, and that the pollen is the real exciting cause.

The indications, however, are that not only has the medical profession generally accepted the relationship of pollen to hayfever, but also that the laity has become educated in the fact that pollen is the exciting cause. This is especially important in the consideration of the prevention of hayfever.

PREVALENCE OF HAYFEVER.

From the standpoint of the number of patients affected, hayfever ranks among the first of the non-fatal diseases. While exact statistics regarding the number of hayfever subjects are not available, the number of cases in the United States, based upon available information, is about 1,000,000, or 1 per cent of the total population.

In June, 1916, at the request of the American Hayfever Prevention Association, a questionnaire, under the supervision of the United States Public Health Service,[1] was mailed to all the physicians of Louisiana, the analysis of which indicated that the number of hayfever subjects in Louisiana is about 1 per cent of its population. Our reports from other sections also indicate that this is a fair average for the eastern states generally.

West of Kansas, hayfever was formerly supposed to be uncommon, but our investigations have shown that hayfever in this section, while not as common as a whole as in the eastern and southern states, is by no means infrequent, and is, moreover, constantly increasing. Reports from California and Colorado show that hayfever is a common disease in these states.[2] Our correspondent in Santa Fé, New Mexico, states that there is a "great deal" of hayfever in that section. Another from the state of Washington reports that hayfever is exceedingly common. Our records

[1] Scheppegrell: Hayfever in Louisiana, New Orleans Med. and Surg. Jour., October, 1916.

[2] Seven hundred cases among the employees of one of the railroad companies have been reported by Dr. Grant Selfridge, our representative in California.

also show that hayfever is common in Montana, Oregon, Idaho, Arizona, Wyoming, Utah and Nevada.[1]

Hayfever is far more prevalent in the United States than in Europe. In the former the autumnal hayfever is much more common, while in Europe the spring form is the prevailing type.

While hayfever is not a disease with a fatal tendency, the distressing character of its symptoms causes it to be more dreaded by its victims than many more serious diseases. The prolonged irritation, the impeded nasal respiration, the sleepless nights, the prolonged nervous depressions, to which are frequently added severe asthmatic attacks, form a combination of distressing symptoms which is aggravated by the probability of its annual recurrence.

In view of this, and the large number who suffer from hayfever, the consideration of this disease is entitled to a prominent position, both as to the investigation of the causes, and of the prevention and treatment.

[1] Scheppegrell: Hayfever; its Cause and Prevention in the Rocky Mountain and Pacific states, United States Pub. Health Rep., July 20, 1917.

CHAPTER II.

POLLEN.[1]

In order to understand the relation of pollens to hayfever, and the reason that certain varieties are so abundant in the atmosphere, it will be well first to consider the nature of pollen, and its relation to flowers in general.

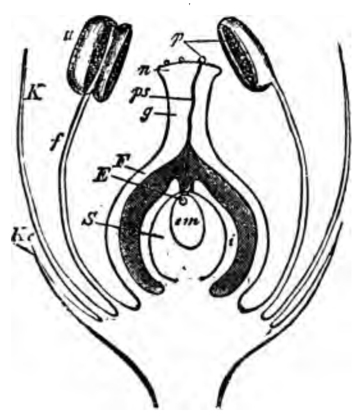

FIG. 1.—A typical flower.

In order to be perfect, a flower must have two sets of organs: (1) One or more bodies occupying the center of the flower, called pistils; and (2) around these a set of bodies, varying in number from one to many, called stamens. What is popularly called the "flower," the bright-colored portion, is really only an accessory, which may or may not be present. In Fig. 1, the center of the flower is occupied by one large

[1] Scheppegrell: Hayfever and its Prevention, United States Pub. Health Rep., July 21, 1916.

pistil. The basal portion is the ovary (*F*), which in this case contains a single seed (*S*), as yet undeveloped.

On the top of the ovary is a short tube, the style (*g*), while the extreme tip of the style is the stigma (*n*). The two or three little grains on the top of the stigma (*p*), shown in the figure, are the pollen grains.

Around the pistil are two stamens, each consisting of a stalk or filament, at the end of which is a sack-like body, divided into two partitions, the anther (*a*). The anther is the organ in which the pollen is formed.

No plant can form a perfect fruit with seeds unless it has been fertilized by pollen. This must first be deposited on the stigma (pollination), and the pollen grain must germinate and grow down the style until it reaches the ovule in order to complete the process of fertilization.

In perfect flowers, in which the two kinds of organs are almost touching each other, as is very often the case, pollination is a very simple matter. But there are many flowers which are not perfect, some containing stamens only and others only pistils. In these cases the pollen may have to travel a considerable distance, even several miles, to reach a pistil. This is the case with the persimmons, willows, the ragweeds, grasses and many other plants.

FORM OF POLLEN.

Pollen grains are of different sizes, shapes and colors. The size varies from small pollens such as that of the trailing mimosa (*Mimosa trigolosa*) (Fig. 2), which measures only 6 microns in diameter, to that of the marshmallows (*Hibiscus*), which are so large (180 microns) that they can easily be seen with the unaided eye. The relative sizes of the marshmallows and false wormwood are shown in Fig. 3. The color is most frequently yellowish, but may be white, red or other colors.

The shape is usually spherical or ovoid, which is the case with the ragweeds (Fig. 4), the grasses (Fig. 5) and many of the tree pollens (Fig. 6). Sometimes it is prismatic as with some of the sedges, and occasionally there are other

shapes, as in the showy primrose (Fig. 7), the flowering crabapple (*Pyrus japonica*) (Fig. 8), and the flowering sage

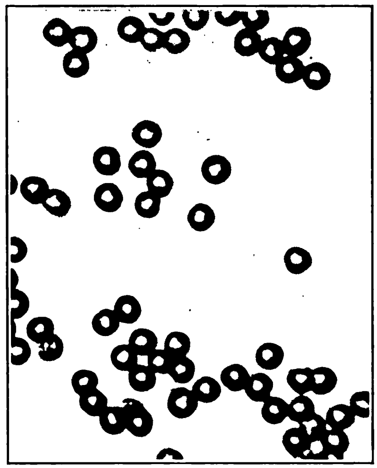

Fig. 2.—Pollen of trailing mimosa (*Mimosa trigolosa*). A small form of pollen. (× 500.)

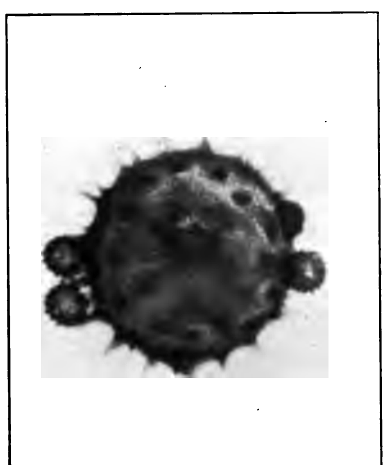

Fig. 3—Pollens of hibiscus and false wormwood (*Parthenium hysterophorus*), showing relative size. (× 250.)

(*Salvia splendens*) (*Fig.* 9). The shape is not only similar with the various species, but is usually characteristic of the

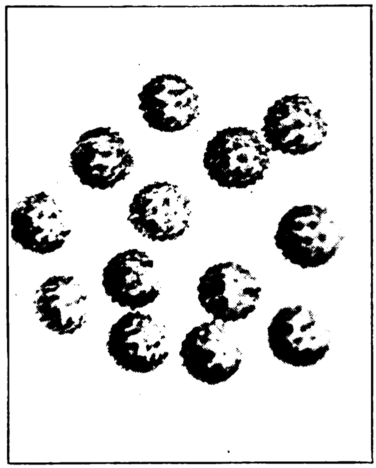

FIG. 4.—Spherical pollen of common ragweed (*Ambrosia elatior*) on test plate. ($\times$ 500.)

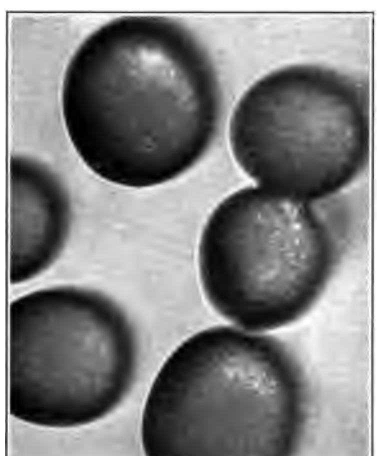

FIG. 5.—Ovoid pollen of barnyard grass (*Panicum crusgalli*). ($\times$ 500.)

whole genus, so that it is of valuable assistance in their identification. In the wormwoods (*Artemisias*), for instance,

Fig. 6.—Spherical pollen of the hard maple (*Acer drummondi*). (× 500.)

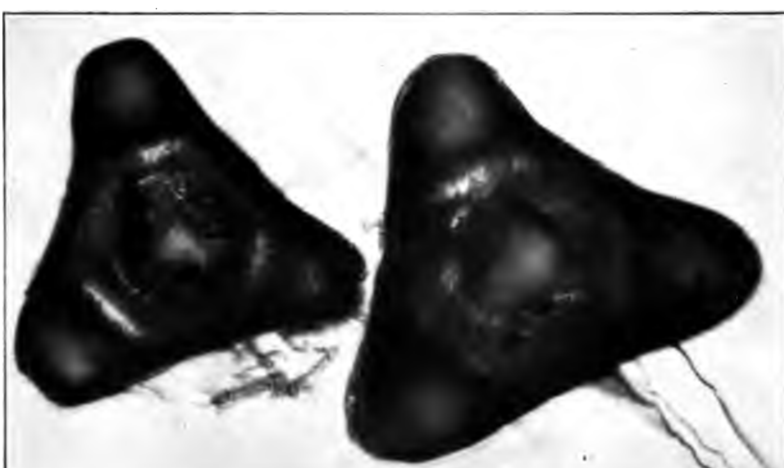

Fig. 7.—Pollen of showy primrose (*Hartmannia speciosa*); an unusual form. (× 500.)

which has a three-lobed pollen (Fig. 10) all the species that have been examined by us have this characteristic shape.

Fig. 8.—Pollen of flowering crabapple (*Pyrus japonica*); decorative pollen. (× 500.)

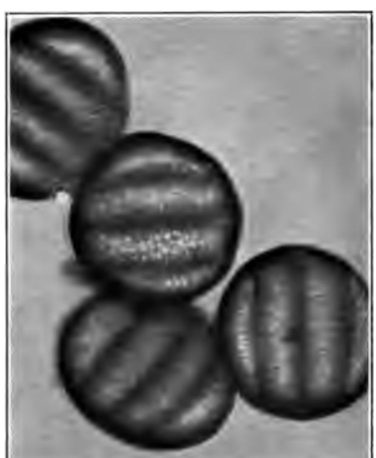

Fig. 9.—Pollen of flowering sage (*Salvia splendens*); a multilobular form. (× 500.)

FIG. 10.—Pollen of mugwort (*Artemisia heterophylla*); the type of the wormwood pollen. (× 500.)

FIG. 11.—Winged pollen of pine (*Pinus coulteri*). Reflected light. (× 500.)

The pine pollens, which fortunately are harmless in hayfever, are provided with wings or double parachutes (Fig. 11), which enables them to traverse distances out of proportion to their size.

The appearance of many pollens vary under atmospheric conditions. This refers especially to the spherical pollens of the grasses and trees. When exposed to the drying effects of the air, they lose a portion of their moisture, and present a shrivelled appearance under the microscope. The

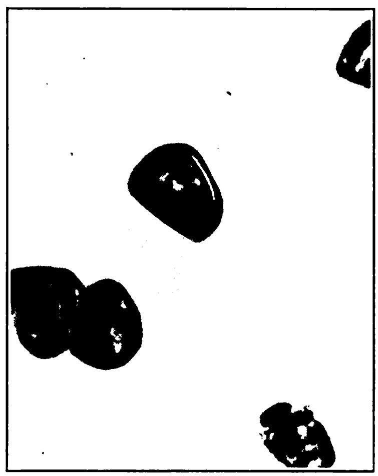

FIG. 12.—Pollen of June grass (*Poa annua*), showing effects of moisture (Lugol's solution). (× 500.)

addition of a normal saline solution, or other liquid, quickly restores the spherical form (Fig. 12). The pollen of the ragweeds, and similar spiculated pollens, are not noticeably affected by this exposure.

While pollens have various markings, these may be divided into two general classes: Those having spines or spicules and those without these, or *spiculated* and *unspiculated*. The ragweeds (Fig. 4) form the type of the spiculated pollen and the grasses (*Gramineæ*) (Fig. 5) of the unspiculated.

The spicules increase the buoyancy of pollen and materially aid them in travelling long distances under favorable wind conditions.

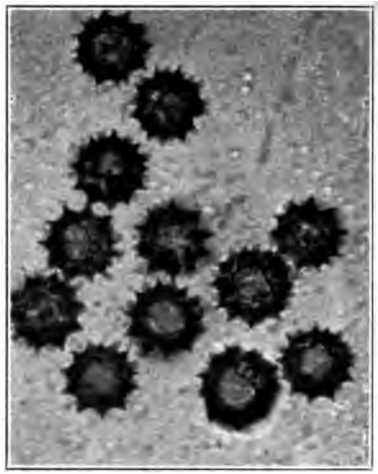

Fig. 13.—Pollen of sneezeweed (*Helenium multiflorum*), with few and distinct spicules. (× 500.)

Fig. 14.—Pollen of cockle bur (*Xanthium americanum*), with numerous small spicules. (× 500.)

The spicules of pollen form one of the means of their identification. In the sneezeweed (*Helenium multiflorum*)

Fig. 15.—Pollen of rose of Sharon (*Hibiscus syriacus*), with lanceolate spicules. (× 250.)

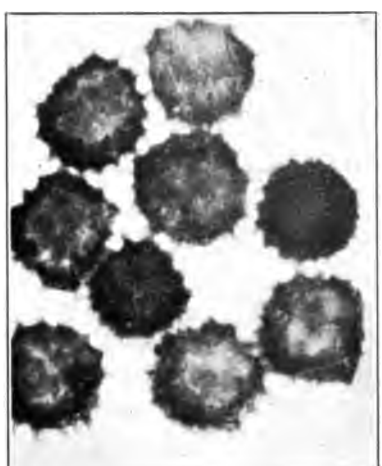

Fig. 16.—Pollen of dahlia with lanceolate spicules. (× 500.)

(Fig. 13), for instance, they are few and distinct, while in the cockle bur (*Xanthium americanum*) (Fig. 14), they are

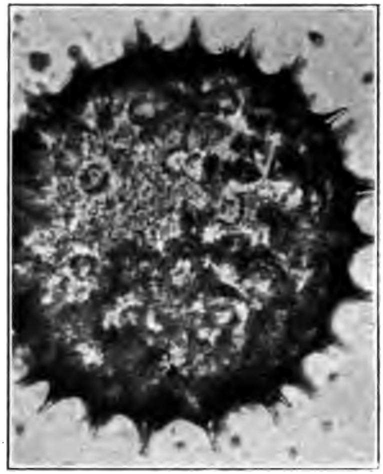

Fig. 17.—Pollen of cotton with lanceolate spicules. (× 500.)

Fig. 18.—Pollen of leadwort (*Plumbago larpentæ*), showing surface markings. (× 500.)

small and numerous. In the rose of Sharon (*Hibiscus syriacus*) (Fig. 15) and dahlia (Fig. 16), they are at considerable

FIG. 19.—Pollen of black walnut (*Juglans nigra*), with characteristic markings. (× 500.)

FIG. 20.—Pollen of "lady's thumb" (*Polygonum persicaria*), with surface protuberances. (× 1000.)

intervals and lanceolate, which is also the case with the pollen of the cotton (Fig. 17).

In the unspiculated pollens, the surfaces frequently have characteristic markings, as shown in the pollen of the leadwort (*Plumbago larpentæ*) (Fig. 18) and black walnut (*Juglans nigra*) (Fig. 19). Except in the larger pollens, it requires the higher powers of the microscope (1000 diameters), to show these with sufficient distinctness to be of aid in their identification (Figs. 20 and 21).

FIG. 21.—Pollen of magnolia (*Magnolia grandiflora*), with surface markings. (× 500.)

CHEMICAL COMPOSITION OF POLLEN.

The chemical analysis of pollens shows that they invert cane sugar, invertin being present in the grain previous to germination. They also contain diastase and are capable of dissolving starch paste if present in culture fluid. The intine or inner coat is usually rich in cellulose, and also in pectin. Most pollen grains contain starch, this being especially the case with the grass (*Gramineæ*) pollens. Protein is present, this being about 25 per cent. in the ragweed

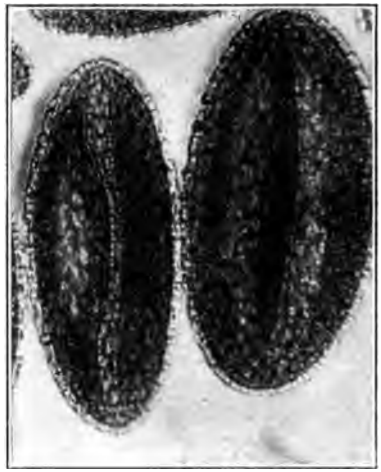

FIG. 22.—Pollen of spotted lily (*Lilium martagon*), showing formation of extine. (× 500.)

FIG. 23.—Pollen of common ragweed (*Ambrosia elatior*) in chloral hydrate, showing nuclei. (× 500.)

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(*Ambrosia elatior*) pollen, and is of special importance from a hayfever standpoint.

When stained with chloro-zinc-iodine, the extine (Fig. 22) is stained brown and the intine blue. Many pollen grains contain oil. In sulphuric acid the intine immediately dissolves but the extine remains. The contents are colored rose-red. In a solution of chloral hydrate, most pollens become transparent, so that the nuclei may be observed (Fig. 23). In Lugol's solution, the grass pollens quickly

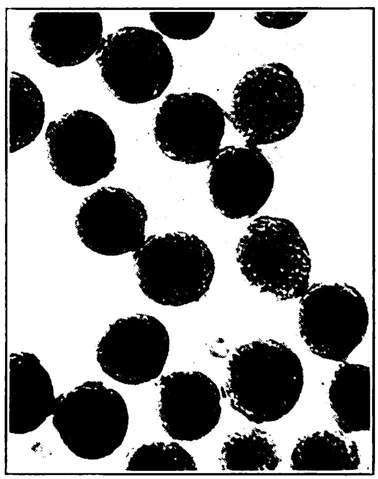

FIG. 24.—Pollen of June grass (*Poa annua*) in Lugol's solution, showing starch reaction. ($\times$ 500.)

show the characteristic blue reaction of starch (Fig. 24), which is a useful means for their differentiation from other pollen. In Fig. 25, for instance, showing grass and sedge pollen, the former are easily distinguished from the sedge pollen of this reaction. In Fig. 26 the combined effect of chloral hydrate and Lugol's solution is shown in the pollen of the pine, by means of which the "wings" are clearly distinguished.

In the pollen of certain conifers, such as the cedars, the addition of a saline solution, or of glycerin, causes swelling

of the inner coat (intine), which results in the shedding of the outer coat (extine) (Fig. 27). As a result of this, they

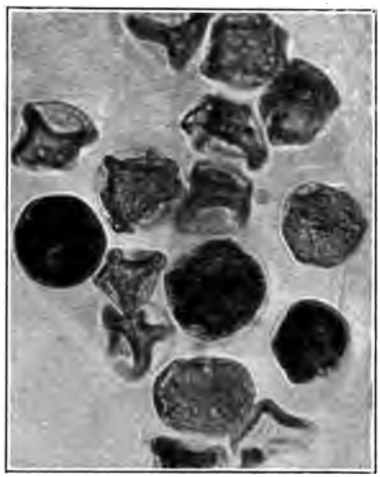

FIG. 25.—Pollen of grass and sedge in Lugol's solution, showing difference in reaction. (× 500.)

FIG. 26.—Pollen of pine (*Pinus coulteri*) in chloral hydrate and Lugol's solution, showing the "wings."

present a characteristic appearance when found in the glycerin of the atmospheric-pollen plates, which simplifies their identification.

The following is an analysis of the ragweed pollen by Frederick W. Heyl:[1] Alcohol soluble, 42.9 per cent; moisture, 5.3 per cent; crude fiber, 12.2 per cent; pentanes, 7.3 per cent; ash, 5.4 per cent; dextrin, 2.1 per cent; protein, 24.4 per cent. Of the protein, about 7.5 per cent could not be extracted, while 6.75 per cent was extracted with diluted

FIG. 27.—Pollen of red cedar (*Juniperus virginiana*) on atmospheric-pollen plate, showing shedding of the extine. (× 500.)

alkali, and only about 5 per cent with 10 per cent salt solution. The albumin and globulin fraction is, therefore, quite small. The analytical figures indicate the presence of proteoses. The nitrogen in the alcoholic extract (1.08 per cent) is probably a base, and the nitrogen in the saline extract after alcohol had precipitated the proteins (1.9 per cent) probably contains this base, and also some proteose.

The alcoholic extract (42.9 per cent) contains: Fat, 10.8

[1] Analysis of Ragweed Pollen, Jour. Am. Chem. Soc., July, 1917.

per cent; lecithin, 0.75 per cent; ether soluble but not ligroin soluble, 1.75 per cent; sucrose, 0.4 per cent; glucose, 1.6 per cent; resin, 17.4 per cent; and a nitrogenous base.

CONVECTION OF POLLEN.

There are two principal methods by which pollen is carried from one plant to another. One is by insects, and the other by the wind. In the first case the flower is usually bright-colored, or white if it blooms at night, sweet smelling and with honey glands, and the pollen grains are comparatively few. In the wind-pollinated plants, the flowers have none of these characteristics, and the pollen is formed in immense quantities and is light and buoyant.

The only pollens which can cause hayfever, except on direct inhalation, are those which are carried by the wind, and are therefore in the air. In warm climates, where weeds of some kind are growing almost constantly, there is probably no month in the year in which there is not some pollen in the air. All plants that have very inconspicuous flowers, as is the case with the most of our common weeds, which are very numerous and form pollen in great abundance, are probably wind-pollinated, and may be regarded as suspicious from a hayfever standpoint.

The distance to which hayfever pollens may be carried by the wind is influenced by the size and form of the pollen, and by meteorological conditions. This is explained in the chapter on Potential Area of Hayfever Pollen.

CHAPTER III.

HAYFEVER PLANTS.

THE characteristics of hayfever plants in general may be summarized as follows: (1) They are wind-pollinated; (2) very numerous; (3) the flowers are inconspicuous, without bright color or scent; (4) the pollen is formed in great quantities (Fig. 28). These are the characteristics of almost all plants which occur as weeds in empty lots, neglected gardens, sidewalks and waste land generally.

All plants having the above qualities are suspicious from a hayfever standpoint. To place them definitely in the hayfever class, however, they must pass the biological test. A small amount of the pollen is applied to the nostril of a hayfever subject, or to the angle of his eye, and, if this produces a hayfever reaction, it completes the test, and the plant is classified with the hayfever plants. These tests may also be made by means of the skin, which is the usual method for making the diagnostic test before immunizing patients against hayfever. (See Cutaneous and Intradermal Tests.) *In order to be positive, these reactions must be capable of being produced not only during the hayfever season, but at any time of the year.*

To establish the responsibility of a plant for hayfever, therefore, both the *botanical* and *biological* tests are required. The botanical test is not sufficient, as many plants, in spite of being wind-pollinated and numerous and with insignificant flowers, may be harmless because they fail in the biological test.

On the other hand, many plants which pass the biological test, do not enter the hayfever class because they are not numerous, or are not wind-pollinated, so that their pollen is not in the atmosphere and cannot reach the nostrils of

susceptible persons except by direct contact with the flower. The failure to include this botanical test has resulted in placing many harmless plants, such as the rose and golden rod, in the hayfever list.

FIG. 28.—Flower (florescence) of marsh elder (*Iva ciliata*), showing profusion of pollen.

TYPE OF HAYFEVER PLANTS.

The plants which form the type of hayfever-producing plants are the common ragweed (Fig. 29) and the giant ragweed (Fig. 30). In the former the pollen is not only

wind-borne, but is produced in such abundance that a slight blow will dislodge it in clouds, and is so buoyant that the wind will easily carry it to a considerable distance. Under favorable climatic and soil conditions this weed is found in every neglected field, on roadsides and in vacant city lots.

In moist lands of certain sections, as on the gulf coast, the giant ragweed takes its place and is found in similar

FIG. 29.—Common ragweed (*Ambrosia elatior*); the type of hayfever weeds.

profusion. These two varieties of ragweed have been found by the research department of the American Hayfever Prevention Association to be responsible for about 85 per cent of all cases of autumnal hayfever in the sections in which these weeds are prevalent. In the Pacific and Rocky Mountain states the wormwoods (*Artemisias*) replace the ragweed as the principal cause of hayfever.

TERMINOLOGY.

In the description of hayfever plants, both the most common, popular and the botanical name will be given.

FIG. 30.—Giant ragweed (*Ambrosia trifida*); typical hayfever weed.

The futility of giving only the common name is shown by the fact that the most common hayfever weed in the United States (*Ambrosia elatior*) is known in various sections by the following names: "ragweed," "Roman wormwood," "hogweed," "wild tansy," "bitterweed," "stickweed,"

"stammerwort," "carrot weed," "black or tasselweed," and "hayfever weed."

Among the hayfever trees also, there is a dissimilarity of common names as indicated by the following names in use for the *Populus tremuloides:* "Aspen" (New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Illinois, Indiana, Wisconsin, Michigan, Minnesota, North Dakota, Nebraska, Ohio, Oregon, Utah, Idaho, Nevada, Montana, Colorado, California); "quaking asp" (New York, Pennsylvania, Delaware, California, New Mexico, Idaho, Colorado, Arizona, Illinois, Iowa, Minnesota, Montana, Nebraska, Utah, Oregon, Nevada); "mountain asp" (Montana); "American aspen" (Vermont); "aspen leaf" (Pennsylvania); "white poplar" (Massachusetts); "trembling poplar" (Minnesota, Colorado); "American poplar" (Minnesota, Colorado); "poplar" (Vermont, New York, Illinois, Indiana, Minnesota, Montana); "popple" (Wisconsin, Iowa, Montana); "tremble" (Quebec); "trembling aspen" (Iowa); and "aspen poplar" (California, Montana).

Even the botanical names vary to some extent with different botanists, but we have selected those accepted by the United States Department of Agriculture, which has furnished us with valuable coöperation in our work.

CHAPTER IV.

COMMON HAYFEVER PLANTS OF THE EASTERN AND SOUTHERN STATES.

THE following is a list of the principal hayfever plants which are found in the eastern and southern states. Some of these, such as the western ragweed (*Ambrosia psilostachya*) and the cockle bur (*Xanthium americanum*) are also found in the Pacific and Rocky Mountain states.

1. Common ragweed, Roman wormwood (*Ambrosia elatior* or *Artemisiæfolia* (Fig. 31). This *Ambrosia,* or ragweed, is called *Artemisiæfolia* on account of its leaves resembling those of the wormwood (*Artemisia*). It is the most important hayfever plant in the United States. It is an annual with leaves much cut and thin, opposite and alternate, as shown in the illustration. The leaves are variable, however, those on the flowering branches sometimes being undivided. It has spikes of green flowers (staminate) at the end of the branches. The pistillate or fertile flowers are at the intersection of the branches with the stalks.

It is found along roadsides and in dry situations, especially in fields where a crop of wheat, rye or oats has been harvested in early summer and afterward neglected. It grows from 1 to 5 feet in height and blooms from August to October or later. It is a native of America and is found in dry soil from Nova Scotia to Florida and west to British Columbia and Mexico. It is comparatively rare and local west of Kansas, and is then replaced by the western ragweed (*Ambrosia psillostachya*), the sand bur (*Franseria acanthicarpa*) and the marsh elder (*Iva axillaris*), all of which also have abundant wind-borne pollens. It has a spiculated pollen (Fig. 32), 15 microns in diameter.

2. Giant ragweed (*Ambrosia trifida*) (Fig. 33). A tall unsightly weed, also called "horse weed" and "blood weed," 6 to 15 feet high, with a rough, hairy stem. The lower leaves are deeply three-parted, with separate margins.

FIG. 31.—Common ragweed (*Ambrosia elatior*), the principal cause of autumnal hayfever in the United States.

Some of the upper leaves are undivided, oval or ovate in shape. The flowers are in panicled racemes (Fig. 34), the upper flowers staminate, the lower pistillate. It is common in moist soil from Quebec to Florida, and west to Nebraska,

FIG. 32.—Pollen of the common ragweed (*Ambrosia elatior*). Reflected light. (× 500.)

FIG. 33.—Giant ragweed (*Ambrosia trifida*); a common cause of autumnal hayfever in moist sections.

Colorado and New Mexico. In the moist land near the gulf coast it forms about 80 per cent of all the ragweeds. It blooms from August to October. The pollen resembles that of the common ragweed, both in appearance and reaction, but is larger (20 microns) (Fig. 35).

FIG. 34.—Flowers of the giant ragweed (*Ambrosia trifida*), showing panicled racemes.

3. Western ragweed (*Ambrosia psilostachya*) (Fig. 36). A perennial weed, 2 to 5 feet high, growing from running root-stocks, thicker and stouter than the common ragweed,

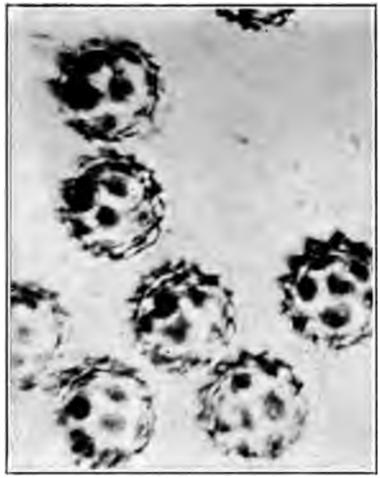

Fig. 35.—Pollen of the giant ragweed (*Ambrosia trifida*) from atmospheric-pollen plate. ($\times$ 1000.)

Fig. 36.—Western ragweed (*Ambrosia psilostachya*); a minor cause of hay-fever from Illinois to Saskatchewan, Texas, Mexico and California.

covered with loose shaggy white hair; the leaves are thick, much divided, the lobes of the leaves lanceolate and acute; the staminate heads on short pedicles; the fruit is solitary in the axils below. This is the common form in the prairie country of Louisiana and in the west generally, where it replaces the common ragweed. It is found in moist open soil from Illinois to Saskatchewan, Texas, Mexico and California. It blooms from July to October. The pollen resembles that of the common ragweed, but is larger (25 microns) (Fig. 37).

FIG. 37.—Pollen of the western ragweed (*Ambrosia psilostachya*). (× 500.)

4. Cockle bur (*Xanthium americanum*) (Fig. 38). A coarse annual, with branching stems and alternate petioled leaves. The leaves are broadly ovate, cordate, usually three-lobed and simply or doubly dentate. The sterile and fertile flowers are in different heads, the latter clustered below, the former in short spikes; the fruit, a rough bur, with usually two curved beaks and covered with prickles straight-tipped or hooked, 2 to 6 feet high. It grows in rich soil, especially in moist places. June to November. It has a spiculated pollen (Fig. 14), 32 microns in diameter.

Fig. 38.—Cockle bur (*Xanthium americanum*); a cause of hayfever from Ontario to Florida, Michigan, Tennessee and Kansas.

Fig. 39.—Russian thistle (*Salsola pestifer*); a cause of hayfever in the central and western states.

5. Russian thistle (*Salsola pestifer*) (Fig. 39). Annual, with much-branched, spreading stem, 4 to 6 feet in height, with slender alternate, spiny-tipped leaves and small flowers in the axils of the leaves. It is a troublesome weed from

Fig. 40.—Marsh elder (*Iva ciliata*); a cause of hayfever in moist soil, from Illinois to Nebraska and south to Louisiana and New Mexico.

New Jersey to Ontario, the northwestern territory, Kansas and Washington, and is one of the causes of hayfever in this section.

6. Marsh elder (*Iva ciliata*) (Fig. 40). An annual, 3 to

6 feet high, with a rough, hairy stem, and small nodding greenish-white heads of flowers, each subtended by a leafy bract. The leaves are ovate, pointed, coarsely toothed, downy beneath, and on slender ciliate petioles; the bracts of the involucre and fertile flowers are three to five. It grows in moist ground and waste places generally, from Nebraska south to Louisiana, Texas and New Mexico. It blooms from August to November. It has a spiculated pollen (Fig. 41), 25 microns in diameter, which resembles that of the ragweed in appearance and in its hayfever reaction.

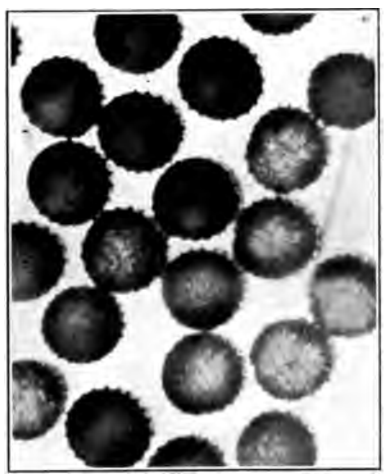

FIG. 41.—Pollen of marsh elder (*Iva ciliata*). (× 500.)

7. Spiny amaranth or careless weed (*Amaranthus spinosus*) (Fig. 42). A smooth, bushy branched annual, naturalized from tropical America. Stem reddish; leaves ovate to ovate-lanceolate, dull green; a pair of spines in their axils. Flowers small, greenish-yellow, crowded in close and small axillary clusters; staminate and pistillate flowers separate, three stamens to a flower. Three to 6 feet high, widely spreading. It grows in waste ground generally, and is common on empty ground that has been cultivated. It blooms

from April to December. The pollen (Fig. 43) is unspiculated, and measures 20 microns in diameter.

8. Yellow dock (*Rumex crispus*) (Fig. 44). Coarse herbs, with small greenish-brown flowers, with crowded and commonly whorled panicled racemes; the petioles of the leaves

FIG. 42.—Spiny amaranth (*Amaranthus spinosus*); a minor cause of hayfever in the South.

sheathing at the base. It grows 2 to 3 feet high. The leaves have strongly wavy, curled margins, lanceolate and acute. It is found in North America generally, and blooms from June to August. Other members of the dock and of the goosefoot (*Chenopodium*) and water-hemp (*Acnida*) families give similar hayfever reaction as the yellow dock.

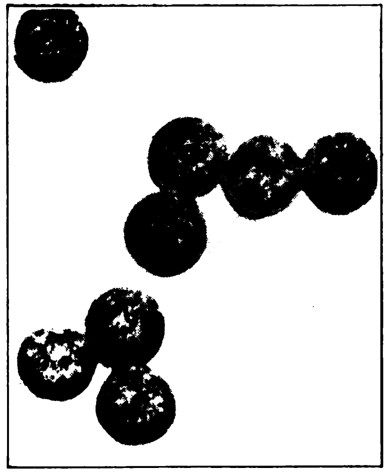

FIG 43.—Pollen of spiny amaranth (*Amaranthus spinosus*). (× 500.)

FIG. 44.—Yellow dock (***Rumex crispus***); a minor cause of hayfever in the United States generally, and southern British America.

FIG. 45.—False wormwood (*Parthenium hysterophorus*); a cause of perennial hayfever in the South.

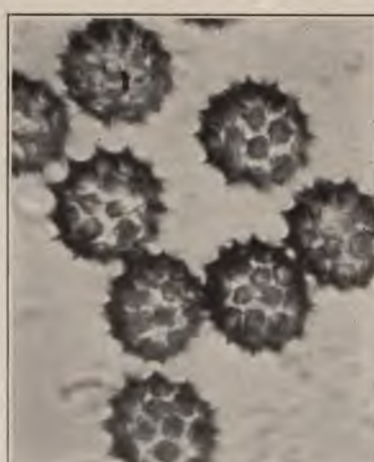

FIG. 46.—Pollen of false wormwood (*Parthenium hysterophorus*). (× 1000.)

9. False wormwood, or bastard feverfew (*Parthenium hysterophorus*) (Fig. 45). Two to 3 feet high, with small white flowers, resembling tiny cauliflowers. It is almost always in bloom and may, therefore, cause hayfever at any season of the year. It is very common along the streets and sidewalks, and in vacant city lots. Leaves much divided, hairy, closely resembling the leaves of the common ragweed, from which it can easily be distinguished by the small white flowers. It is found from southern Pennsylvania to Illinois, Missouri, Florida and Texas. The pollen (Fig. 46) is spiculated and measures 15 microns in diameter.

TREES IN HAYFEVER.

Many of the trees are wind-pollinated and, in some varieties, distribute their pollen in immense quantities. The most active of these that we have tested are the oaks. There are about sixty-five varieties of oaks that are sufficiently common in the United States to be of consideration in hayfever. The following is a list of the most important varieties:

Red oak	*Quercus rubra*
Swamp	*Quercus palustris*
Schneck's	*Quercus schneckii*
Gray	*Quercus borealis*
Hill's	*Quercus elipsoidalis*
Scarlet	*Quercus coccinea*
Black	*Quercus velutina*
Spanish	*Quercus trilobata*
Elliotts	*Quercus pagodæfolia*
Scrub	*Quercus illicifolia*
Black jack	*Quercus marylandica*
Black jack	*Quercus nigra*
Willow	*Quercus phellos*
Laurel	*Quercus laurifolia*
Shingle	*Quercus imbricaria*
White	*Quercus alba*
Post	*Quercus stellata*
Swamp post	*Quercus lyrata*
Bur	*Quercus macrocarpa*
Swamp white	*Quercus bicolor*
Basket	*Quercus michauxii*
Rock chestnut	*Quercus prinus*
Yellow	*Quercus muhlenbergii*
Dwarf chestnut	*Quercus prinoides*
Live oak	*Quercus virginiana*

The oaks pollinate from March to June, according to the varieties and climate. This is also the season for the pollination of the grasses, and the patients with spring hayfever should, therefore, be tested for both pollens before being immunized. The pollen of the oak (Fig. 47) gives a hayfever reaction somewhat similar to that of the grasses, but relatively less active than that of the ragweeds.

Among the trees the pollen of the cedars (*Juniperus*) are next to the oaks in importance in hayfever. Some varieties

FIG. 47.—Pollen of water oak (*Quercus nigra*); a local cause of hayfever from Delaware to Kentucky, Missouri and Texas. (× 500.)

(*Juniperus sabinoides*) pollinate very early (February) in some sections (northern Texas, etc.), and form an important factor in the hayfever season (Fig. 48). In some sections the black walnut (*Juglans nigra*) (Fig. 19) is responsible for an early form of hayfever.

The cottonwoods (*Populus*) are also important in hayfever, as the pollen of some varieties give a marked hayfever reaction (Fig. 49). This is especially the case with the western cottonwood (*Populus sargentii*) (Fig. 50), which is a common cause of hayfever in sections in which it is found

FIG. 48.—Pollen of mountain cedar (*Sabina sabinoides*); a cause of spring hayfever in northern Texas. (× 500.)

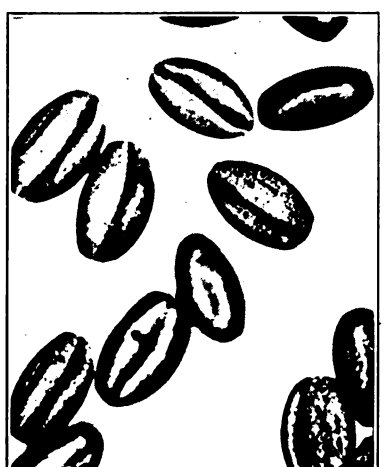

FIG. 49.—Pollen of Carolina poplar (*Populus deltoides*); a local cause of hayfever from Quebec to Manitoba, south to Connecticut, Florida and Tennessee. (× 500.)

in sufficient abundance. Other members of the cottonwood family also give a positive reaction, but less active than that of the western. Among the varieties which we have tested and found positive are the following: Narrow-leaved cottonwood (*Populus angustifolia*), swamp cottonwood (*Populus heterophylla*), yellow cottonwood (*Populus deltoides*) and Arizona cottonwood (*Populus arizonica*).

FIG. 50.—Cotton wood (*Populus sargentii*); a local cause of hayfever from Saskatchewan to North Dakota, Nebraska, Kansas and New Mexico.

The pollen of the willows (*Salix*) (Fig. 51) gives a hayfever reaction, and also that of the elms (*Ulmus*) (Fig. 52), and hackberry (*Celtis*) (Fig. 53). These pollens, however, have so mild a reaction that they give hayfever only when inhaled in large numbers as when planted in close proximity to a

Fig. 51.—Pollen of black willow (*Salix nigra*); a local cause of hayfever from North Dakota to Florida and Texas. (× 500.)

Fig. 52.—Pollen of elm (*Ulmus americanus*); a local cause of hayfever from Newfoundland to Manitoba, Florida and Texas. (× 500.)

residence, or when the patient is already suffering from other pollens.

The members of the pine family (*Pinus*) generate pollen in enormous quantities. While the pollens are large (40 x 50 microns), which would limit their potential area, this is offset by the fact that these pollens are supplied with balloons, or wings (Fig. 11), which gives them great buoyancy and

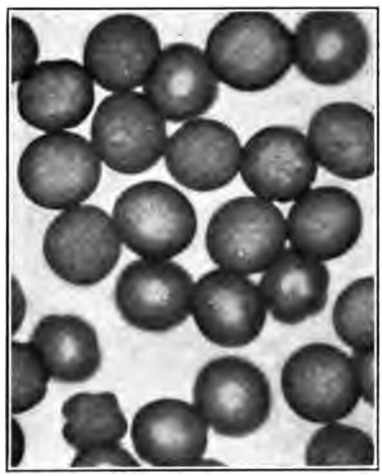

FIG. 53.—Pollen of ash (*Fraxinus americana*); a local cause of hayfever from Nova Scotia to Ontario, Minnesota, Florida, Kansas and Texas. (× 500.)

enables them to traverse great distances. Fortunately, these pollens give a negative reaction in hayfever and we have no authentic report of hayfever from this source.

THE GRASSES.

The grasses (*Gramineæ*) form an important class in the hayfever plants. They have all the characteristics of hayfever plants, being wind-pollinated, very numerous, with inconspicuous flowers without bright color or scent, and the pollen is formed in great quantities.

Fig. 54.—Anther of paspalum grass (*Paspalum dilatum*), showing relative size of pollen. (× 125.)

The anther of bull grass (*Paspalum dilatum*) is shown in Fig. 54. It has a few remaining pollens which illustrate their relative size to the anther. The plumose stigma of the grass is shown in Fig. 55, and some of the attached pollen

FIG. 55.—Plumose stigma of the grass, with attached pollen. (× 125.)

showing how these are caught in its meshes. The anthers of the June grass (*Poa annua*) is shown in Fig. 56, indicating their appearance after the pollen has been discharged.

When the pollen of the grasses are fresh, as when shaken directly from the anther, they present an ovoid appearance

FIG. 56.—Anthers of June grass (*Poa annua*), with pollen already ejected. (× 125.)

FIG. 57.—Pollen of barnyard grass (*Panicum crus-galli*), just discharged from the anther. (× 500.)

(Fig. 57) under the microscope. After exposure, however, they appear collapsed as shown in Fig. 58.

The period of pollination of the grasses commences early in the year (February, March), and they are the principal cause of the spring and summer hayfever. Our investiga-

FIG. 58.—Pollen of Johnson grass (*Andropogon halapense*), shrunk from exposure. (× 500.)

tions have shown that practically all the varieties may cause hayfever in persons susceptible to grass pollens. The grasses (*Gramineæ*) which form the principal cause of hayfever are the following:

NORTHERN UNITED STATES.

Corn (*Zea mays*)
Wheat *Triticum sativum*)
Oats (*Avena sativa*)
Kentucky blue grass (*Poa pratensis*)
Red-top (*Agrostis alba*)
June grass (*Danthonia spicata*)
Timothy (*Phleum pratense*)
Millet (*Chætochloa italica*)
Rye (*Secale cereale*)
Orchard grass (*Dactylis glomerata*)
Chess grass (*Bromus secalinus*)
Salt reed grass (*Spartina cynosuroides*)
Tall fescue grass (*Festuca elatior*)
Oat grass (*Arrhenatherum elatius*)
Couch grass (*Agropyron repens*)

NORTHERN PLAINS.

Corn (*Zea mays*)
Barley (*Hordeum vulgare*)
Squirrel-tail grass (*Hordeum jabatum*)
Meadow barley (*Hordeum nodosum*)
Slender fescue grass (*Festuca octoflora*); (has one stamen.)
Grama grass (*Bouteloua gracilis*)
Awnless brome grass (*Bromus inermis*)
Wheat (*Triticum sativum*)
Forked beard grass (*Andropogon furcatus*)

SOUTHEASTERN UNITED STATES.

Bermuda grass (*Capriola dactylon*)
Southern chess grass (*Bromus uniloides*)
Yellow fox-tail grass (*Chætochloa lutescens*)
Sorghum (*Holcus sorghum*)
Johnson grass (*Holcus halepensis*)
Tall red-top (*Tridens flava*)
Crab grass (*Syntherisma sanguinale*)
Brown beard grass (*Andropogon virginicus* and *scoparius*)
Sea oats (*Uniola paniculata*)

SOUTHERN PLAINS.

Buffalo grass (*Buchloë dactyloides*)
Texas blue grass (*Poa arachnifera*)
Hairy mesquite grass (*Bouteloua hirsuta*)
Schrader's brome grass(*Bromus uniloides*)
False buffalo grass (*Munroa squarrosa*)

MIDDLE WEST (WISCONSIN, MICHIGAN, ILLINOIS, INDIANA, IOWA, MISSOURI, ETC).

Chess grass (*Bromus secalinus*)
Brome grass (*Bromus commutatus*)
Wild rice (*Zinania palustris*)
Wild red-top (*Panicum virgatum*)
Canada lyme grass (*Elymus canadensis*)
Indian grass(*Sorghastrum avenaceum*
Tall red-top (*Tridens flava*)
Grama grass (*Tripsacum dactyloides*)

SEDGES, FERNS AND PALMS.

Many of the sedges produce pollen in large quantities, which, as in the case of the grasses, are wind-borne. Some of these bear such a marked resemblance to the grasses, that they are not distinguished from these by the ordinary observer. This refers especially to the "nut grass" (*Cyperus rotundus*) (Fig. 59), which is common in many of the southern states.

A carefully conducted series of tests of the sedges at our biological laboratory has given negative results in their reaction. The pollen of most of the sedges (Fig. 60) have a dense outer coating (extine), which is the probable cause of this negative reaction, as their chemical composition does not differ materially from that of the grasses.

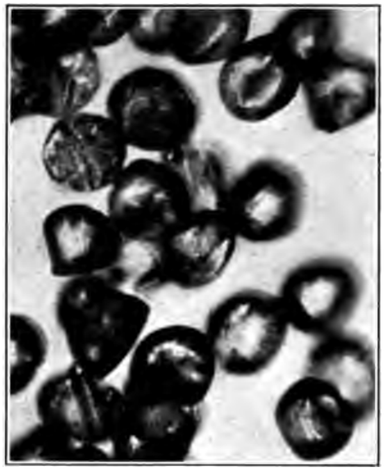

FIG. 59.—Pollen of sedge-nut-grass (*Cyperus rotundus*); negative in hayfever. (× 500.)

FIG. 60.—Pollen of bullrush (*Scirpus lacustris*); negative in hayfever. (× 500.)

FIG. 61.—Spores of cinnamon fern (*Osmunda cinnamonea*); negative in hayfever. (× 500.)

FIG. 62.—Sporange and spores of bracken fern (*Pteridium aquilina*); negative in hayfever. (× 250.)

Some of the ferns bear large quantities of spores (Fig. 61), which have also been supposed to be responsible for hayfever. The bracken fern (*Pteridium aquilinum*) (Fig. 62) is especially prolific in its spores, and was the first to be tested by us for its hayfever reaction. This proved to be negative, which was also the case with the other ferns tested.

FIG. 63.—Pollen of palm; negative in hayfever. (× 500.)

The palms (*Palmaceæ*) also have an abundant wind-borne pollen (Fig. 63). The only varieties, which are fairly common in the United States, are the palmetto (*Sabal palmetto*) in the east, and the San Diego palm (*Washingtonia filefera*) in the west. The pollen of both of these, as well as other palms tested in the biological laboratory of the American Hayfever Prevention Association, have given a negative hayfever reaction.

CHAPTER V.

'FEVER PLANTS OF THE PACIFIC 'CKY MOUNTAIN STATES.

ıon ragweed (*Ambrosia elatior*) (Fig. 31), of fall hayfever in the eastern states, is ' Kansas, it is found in certain sections. olorado it is very abundant in the towns, d in company with the "great ragweed" Fig. 64). The latter should not be con- :at ragweed of the eastern and southern states, which, while belonging to the same family (*Ambrosiaceæ*), is the *Ambrosia trifida*. Their hayfever reaction, however, is similar.

The great ragweed (*Ambrosia trifida*) (Fig. 33), which is a cause of autumnal hayfever in portions of the eastern and especially in the gulf states, is also found in a few sections of the Pacific and Rocky Mountain states. It is found in Wyoming as well as the western ragweed (*Ambrosia psilostachya*), but is not as abundant as the *Iva xanthiifolia* and sagebrush (*Artemisia tridentata*).

In Arizona, some of the ragweeds are found, these being the "great ragweed" (not *Ambrosia trifida* of the western states, but *Ambrosia apteca*) and the "small ragweed" (not *Ambrosia elatior* of the eastern states, but *Gærtneria tenuifolia*).

The western ragweed (*Ambrosia psilostachya*) (Fig. 36) is so common in some parts of California that it is an important factor in hayfever in that state. It is found in moist, open soil from Illinois to Saskatchewan, Texas, Mexico and California. It is a perennial weed, 2 to 6 feet high, growing from running root-stocks, thicker and stouter than the common ragweed, covered with loose shaggy white hairs; leaves

thick, much divided, the lobes of the leaves lanceolate and acute; the staminate heads on short pedicles; the fruit solitary in the axils below.

The most important hayfever weeds of the Pacific and Rocky Mountain states, and which give the most severe reaction, are the wormwoods (*Artemisias*). While their pollen is not produced in the same profusion as that of the

FIG. 64.—Great ragweed (*Iva xanthiifolia*); a cause of hayfever from Ontario to Assinoboia, south to Wisconsin, Nebraska, New Mexico and Utah.

ragweeds (*Ambrosias*), they give a marked hayfever reaction, which in some species is five times as active as that of the ragweeds. The pollens of all the *Artemisias* examined are three-lobed (Fig. 65), and are all smooth with exception of *Artemisia biennis*, which is slightly spiculated.

In California, the mugwort (*Artemisia heterophylla*) and the sagebrush (*Artemisia tridentata*) (Fig. 66) are the principal hayfever plants.

FIG. 65.—Pollen of absinth wormwood (*Artemisia absinthium*) naturalized from Europe; an occasional cause of hayfever. (× 500.)

FIG. 66.—Sagebrush (*Artemisia tridentata*); an important cause of hayfever from Nebraska to Colorado, Utah and California.

In Oregon the wormwoods (*Artemisias*) are also the principal cause, being far more abundant than other hay-fever weeds, such as the water-hemp (*Ivas*), cockle burs (*Xanthiums*), sand burs (*Gærtnerias*) and western ragweed (*Ambrosia psilostachya*), and this is the case in most of this section except in the moist region near the Pacific Coast. In Colorado, on the western slope of the mountains, the sagebrush (*Artemisia tridentata*) covers vast areas almost to the exclusion of other plants. In the sagebrush district persons suffer a great deal from what is popularly called "mountain fever." This has all the symptoms of severe hayfever and is prevalent from August to November, the period of pollination of the sagebrush, and is a form of hayfever and due to the pollen of the sagebrush.

In view of the importance of the *Artemisias* from a hayfever standpoint, a description of the most common varieties is given:

THE ARTEMISIAS.

Artemisia is a genus of mostly bitter and aromatic herbs and shrubs, of which the European wormwood is perhaps the best known.[1] It belongs to the mayweed of the *Compositæ* family, but, unlike the mayweed, the flower heads of *Artemisia* are small, inconspicuous and without rays. In some cases the flowers are apparently self-pollinated; in others the pollen is wind-carried, and in these it is produced in great abundance. There is no reason to suppose that insects aid in their pollination. Only those which are wind pollinated are important from a hayfever standpoint.

The genus comprises some two hundred species. Its greatest development is in the Mediterranean region and in arid North America. About fifty species are found native in the Rocky Mountain and Pacific states, but most of these are of limited distribution, or occur only at high altitudes, or because of some other peculiarity are not important as causes of hayfever.

On the other hand, a few of the species grow in great

[1] Report of Prof. N. M. Hall, University of California.

abundance in the neighborhood of towns and in agricultural districts, where they constitute a serious menace. The California mugwort (*Artemisia heterophylla*) is perhaps the most common of these on ditch banks and in waste places, while the sagebrush (*Artemisia tridentata*) is the most abundant shrub in the great basin area. Both of these have been tested in the biological laboratory of the American Hayfever Prevention Association and have been found to give a marked hayfever reaction.

California Mugwort (*Artemisia heterophylla*).—This name includes several forms, some of which are considered as distinct species by some botanists, but they are all much alike and the properties of the pollen are probably the same for all. The nugwort is an erect perennial herb 3 to 8 feet high. The leaves are rather broadly oblong, 2 to 4 inches long, either cleft or entire, and green above but white beneath. The plants are in bloom from about July to late autumn. They grow either scattered or in masses, often forming thickets on river banks or along ditches. They are especially common on low, moist land.

The banks on which mugwort grows are usually too uneven to permit cutting by mowing machines, but it could be cut by hand with a scythe. The plants would grow up again from the roots, but by cutting the tops occasionally the amount of pollen could be greatly reduced. In suitable situations the mugwort may be expected anywhere from southern California to British Columbia, and east as far as Nevada. It does not grow above an altitude of about 5000 feet, but from Oregon to Alaska it is replaced by the closely related *Artemisia tilessi*, which ranges higher.

Dark-leaved Mugwort (*Artemisia ludoviciana*). (Fig. 67)—In general habit this species is much like the mugwort, but the leaves are usually narrower and are whitened on both faces by woolly pubescence, at least when young. (In *Artemisia ghaphalodes*, a very closely related species and likewise common, the leaves are permanently and densely white-hairy.) The pollen resembles that of the California mugwort. It grows in waste places, especially in dry, stony stream-beds. In California it is quite scattered, only occa-

sionally growing in masses, but it is much more common in the northwest and in the Rocky Mountains, where it grows both on the plains and on stream banks. Its period of bloom and the method of control are similar to those indicated for the mugwort.

FIG. 67.—Dark-leaved mugwort (*Artemisia ludoviciana*); common cause of hayfever from Missouri to Texas, Wyoming, Colorado and Arizona.

Indian Wormwood (*Artemisia dracunculoides*).—The stems of this perennial herb are stiffly erect and grow to a height of 4 to 6 feet. Unlike most *Artemisias,* the herbage is glabrous and green. All of the other species here described, except *Artemisia biennis,* have a gray or whitish herbage. The leaves are mostly entire, 1 to 3 inches long and less than ¼ inch wide. June to September is the period of bloom. Next to the sagebrush, this is perhaps the most common species in western North America. It grows in mountain valleys and on the plains, but is generally absent from the deserts. Sometimes it forms dense stands. In such cases its subjection by mowing would seem feasible.

Sagebrush (*Artemisia tridentata*) (Fig. 66).—The sagebrush is an erect, much-branched, gray shrub with a distinct trunk and shreddy bark. The narrowly wedge-shaped leaves are only ½ to 1½ inches long and mostly three-toothed across the summit, although some of the upper ones are narrower and not toothed. The pollen is produced from August to November. This shrub grows from New Mexico and lower California, north across the high plains of the great basin states, extending even into Washington and Montana. It is by far the most abundant and best-known shrub in this whole region, forming the principal vegetation over thousands of acres. It belongs to the arid district of plains and mountains but does not grow near the coast nor in the hot deserts of the south. In California it is scarcely known west of the Sierra Nevadas.

The sagebrush is sometimes known as "black sage," but it is not to be confused with the true black sage nor with the white sage, both natives of southern California. These true sages belong to the mint family and do not cause hay-fever. Because of its woody, almost arborous habit and great abundance, the elimination of sagebrush will form a difficult problem.

Budbrush (*Artemisia spinocens*).—This is a low, gray shrub with many stiff branches ending in spines. It grows ½ to 1½ feet high. The very small leaves are densely white-hairy and much lobed. The flowering period is earlier than that of most *Artemisias*, the pollen being produced from March to June. The budbrush grows on sandy or somewhat alkaline soil from the Mohave Desert of California, north and east to eastern Oregon, Wyoming and Colorado. It is especially common in Nevada and Utah. Eradication is difficult because of the woody nature of the stems.

California Old Man or Hillbrush (*Artemisia californica*).—This is a gray, highly aromatic shrub, 2 to 4 feet high, best identified by its leaves which are parted into almost thread-like segments. It blossoms from June to October. Geographically, it is restricted to the hills of the coast. It ranges from middle California southward, but there it often forms dense growths of considerable area, especially in southern

California. Since the stems are decidedly woody, the eradication of this plant is also difficult.

Pasture Sagebrush (*Artemisia frigida*) (Fig. 68).—The stems of this plant are woody at base and mostly 1 to 1½ feet high. The herbage is gray and soft because of the many short hairs which cover it and the leaves are finely cut into linear lobes. The plant blooms from July to October. It grows from Idaho, Nevada and New Mexico, to Minnesota

FIG. 68.—Pasture sagebrush (*Artemisia frigida*); a cause of hayfever from Minnesota to Saskatchewan, Idaho, Nebraska, Texas and Arizona.

and Texas and is especially common on the plains of Utah and Colorado. There is much of it around Denver. In Estes Park, Colorado, hayfever is coincident with the blooming of the wormwood sage.

Biennial Wormwood (*Artemisia biennis*).—This is an erect herb, 1 to 3 feet high. It grows from a slender annual or biennial taproot, whereas all others here described have tough, perennial roots, many of them more or less woody.

ie leaves are green and scarcely at all hairy. They are to 3 inches long and deeply cleft into narrow lobes which e sharply toothed. The pollen is shed from July to ecember. This plant occupies open places, especially tch banks and neglected yards, throughout western North nerica, but is not often present in large amounts. It can easily destroyed by pulling, especially when the ground soft, since the root is not deep. Hoary sagebrush (*Arte-sia cana*), Canada wormwood (*Artemisia canadensis* and *rtemisia discolor*), as well as a few others, may be found in iantity at a few places but usually not in proximity to ipulated districts.

Common Wormwood (*Artemisia absinthium*).—This seems have been introduced with seed into eastern Washington, ljacent to Idaho and Oregon. It is spreading quite pidly throughout those localities.

THE IVAS, GÆRTNERIAS AND COCKLE BURS.

Next in importance to the *Artemiasis* are the burweed arsh elder or "great ragweed" (*Iva xanthiifolia*) and the overty weed (*Iva axillaris*).

Their pollens, which are spiculated like those of the rag-eeds (*Ambrosias*), also give a similar reaction for hayfever.

Ivas.—The Western Elder or Poverty Weed (*Iva axillaris*) ?ig. 69).—The poverty weed belongs to the ragweed section the *Compositæ* family, but is unlike all of the ragweeds in its leaves, which are only an inch long, sessile and not at all toothed or cut. The stems are not woody, but grow from perennial creeping rootstocks, so that eradication would be difficult. Cutting close to the ground at the beginning of the flowering season would greatly reduce the amount of pollen produced, but the stems would again shoot up from the same root-stocks. The plants grow in alkaline or saline soil from the Rocky Mountains to the Pacific Coast, and from Canada to Mexico. The blooming period is March to September.

Burweed Marsh Elder, or Great Ragweed (*Iva xanthiifolia*) (Fig. 64).—This is a tall, coarse annual weed with ovate,

sharply-toothed leaves 2 to 6 inches long. In habit and foliage it resembles the common sunflower, although it is not so large, but the small homely heads of flowers are borne in long terminal clusters. It grows from Idaho to Saskatchewan south to New Mexico, but is absent from the Pacific Coast. It blooms in late summer and autumn. Since the root is of only annual duration, any practice which will prevent the plants from going to seed will be effective as a method of eradication. Mowing is advisable where the plants grow in dense stands.

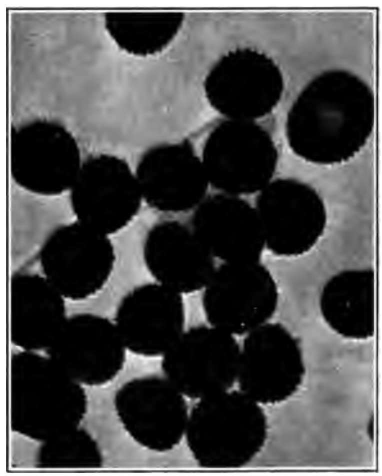

FIG. 69.—Pollen of poverty weed (*Iva axillaris*); a cause of hayfever from North Dakota to western Nebraska, New Mexico and California. (× 500.)

Next to the *Artemisias* and *Ivas*, the *Gærtnerias* were found to be important as an active cause of hayfever. Their pollens, which resemble those of the common ragweed (*Ambrosia elatior*) so closely that it is difficult to distinguish microscopically, also give a similar reaction.

Gærtneria.—Gærtneria (also called *Franseria*) is a genus of herbs and low shrubs with alternate leaves, which are often gray with short stiff hairs and usually lobed or toothed.

It belongs to the ragweed section of the *Compositæ* family, and has pistillate and staminate flowers on the same plant as in the ragweeds. The *Gærtnerias* differ from the ragweeds in the burs which surround the pistillate flowers. These burs are armed with several rows of spines or prickles, while those of the ragweeds have the prickles arranged in a single circle. It is probable that the species are all wind-pollinated, but some of them may be self-pollinated. The pollen (Fig. 70) resembles that of the common ragweed, both in appearance and size and in its hayfever reaction. The most common species in the west are the following:

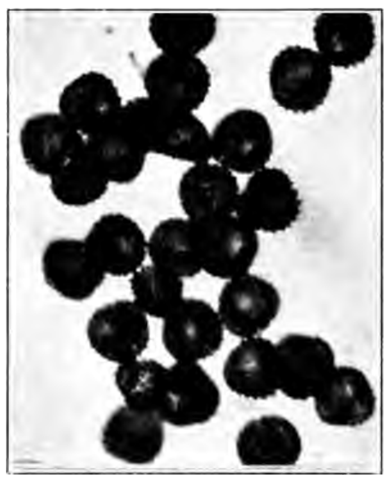

Fig. 70.—Pollen of hairy-leaved gærtneria (*Gærtneria tenuifolia*); a minor cause of hayfever from the western part of the Mississippi Valley to Colorado, Nebraska and southern California. (× 500.)

Sand Bur (*Gærtneria dumosa*).—The sand bur is a low, spreading white-stemmed shrub with brittle, woody branches. The leaves are less than an inch long, parted into many small lobes and white with minute hairs, which cover the surface. It grows in great abundance on the hot, dry deserts from southern Utah to southeastern California and southern Arizona. It is very common along some of the railways

crossing the southwestern deserts. The flowers shed their pollen from about the first of March to the end of June.

False Ragweed (*Gœrtneria acanthicarpa*) (Fig. 71).—This is a spreading and bushy annual or biennial weed. The leaves are ashy gray, ovate in outline but cut into short, rounded lobes somewhat as in ragweed. The flat spines of the bur are straight or only slightly curved. This species inhabits sandy planes and stubble, and is common in arid

FIG. 71.—False ragweed (*Gœrtneria acanthicarpa*); a cause of hayfever from Saskatchewan to western Nebraska and Texas, and west to California.

sections from the Rocky Mountains to the Pacific Coast. In California it is restricted to the southern and eastern parts of the state, and similarly in Oregon and Washington it is found only in the drier parts away from the coast. It is one of the commonest weeds in New Mexico. The blooming period is from August to December (Fig. 72). Since the roots are short-lived the weed may be easily held in check by mowing or burning before the burs ripen. Hand-pulling

is very effective and may be practised where the area covered is not too large.

Gærtneria Tenuifolia.—This perennial very closely simulates the western ragweed in general appearance, but may be distinguished by the burs which have more than one row of spines and these are incurved or hooked. It grows in warm, dry districts from the western part of the Mississippi Valley to Colorado, Nevada and southern California, and ranges south to Texas, but it is not so common as the other species. The pollen is produced during late summer and autumn.

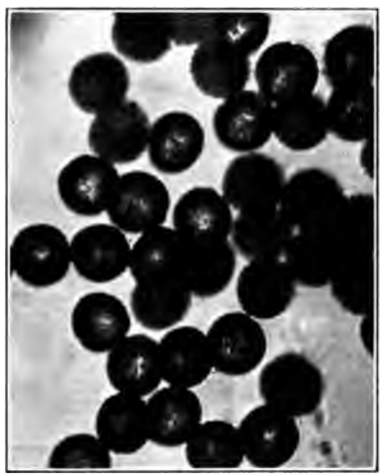

FIG. 72.—Pollen of false ragweed (*Gærtneria acanthicarpa*). × 500.

Gærtneria Bipinnatifida.—The stems of this plant spread along the ground from a perennial root. The white-hairy leaves are much cut into spreading lobes. The burs form in dense clusters toward the ends of the branches, and each cluster is surmounted by a finger-like projection made up of the staminate heads, which yield the pollen. This pollen is produced from April to December. The species grows only on the seashore, usually on the beach sands or dunes, and extends from lower California to British Columbia. From

middle California northward it is accompanied by *Gœrtneria chammissonis*, a very closely related species with merely toothed or cut leaves. Either sort would be difficult to eradicate because of the deep, perennial roots.

Cockle Burs.—The cockle burs (*Xanthium*) (Fig. 38) give a positive reaction for hayfever, but less marked than the *Artemisias*, *Ambrosias*, *Ivas* and *Gœrtnerias*. The pollen is spiculated, but their large size (36 microns) reduces their potential area. It is abundant in some localities, especially on bottom lands along the rivers.

The cockle bur is a coarse annual with branching stems and alternate petioled leaves. In some localities the origin and spread of hayfever has been coincident with the appearance and spread of the cockle bur as a noxious weed. The leaves are broadly ovate, cordate, usually three-lobed and singly or doubly dentate. Sterile and fertile flowers in different heads, the latter clustered below, the former in short spikes. The fruit, a rough bur, usually has two curved beaks and is covered with prickles straight-tipped or hooked, 2 to 6 feet high. It blooms from June to December. It is also found in the eastern and southern states.

OTHER HAYFEVER PLANTS OF THE PACIFIC AND ROCKY MOUNTAIN STATES.

(Minor Importance.)

The hayfever plants of minor importance in this region are the following: Dock (*Rumex conglomeratus* and *obtusifolius*), sheep sorrel (*Rumex acetosella*), goose foot or lamb's quarters (*Chenopodium ambrosioides*), tumble weed (*Amaranthus græcizans*), salt bush (*Hymenoclea salsola*) and grease bush (*Allenrolfea occidentalis*) (Fig. 73). Most of these plants generate pollen in abundance, but they produce a less active hayfever reaction similar to that of the docks (*Rumex*) and amaranths (*Amaranthus*) of the eastern states.

The trees in these states, even when their pollen gives a positive hayfever reaction, are usually only of local importance. An exception, however, is the cottonwood (*Populus*)

and black walnut (*Juglans nigra*) (Fig. 19). Of the varieties of the cottonwood tested, the pollen of the western cottonwood (*Populus sargentii*) (Fig. 50) gives a marked reaction and is responsible for hayfever cases in localities in which

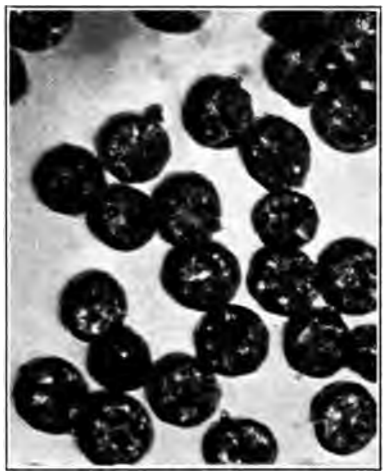

Fig. 73.—Pollen of greasebush (*Allenrolfea occidentalis*); a cause of hayfever in California. (× 500.)

it is found in sufficient quantities. The narrow-leaved cottonwood (*Populus angustifolia*) gives a much milder reaction, and also the Arizona cottonwood (*Populus arizonica*) and yellow cottonwood (*Populus deltoides*) (Fig. 49).

CHAPTER VI.

PLANTS NOT RESPONSIBLE FOR HAYFEVER

When it first became generally known that the pollen of plants were responsible for hayfever, persons suffering from the disease, or interested in its etiology, began to observe what plants were in bloom during its prevalence. As a result of this, many harmless plants were blamed as the cause of this distressing disease.

The golden rod, which blooms in the fall and is conspicuous for its bright display of color, early became associated in the public mind with hayfever, and this error was perpetuated even in our medical works and encyclopedias. The ragweed, cockle burs, grasses and other hayfever plants, however, whose insignificant flowers failed to attract attention, were not suspected.

What gave greater plausibility to the belief that the golden rod, daisies and other bright flowers caused hayfever, was the fact that the pollen of many of these flowers contains a substance which may produce a hayfever reaction in sensitive subjects. These plants, however, are insect-pollinated, and their pollen *is not found in the air*, as in the case of hayfever weeds, so that the irritation can be caused only on direct contact with the flowers.

Golden Rod (*Solidago*) (Fig. 74).—There are about one hundred and twenty-five varieties of the golden rod, most of which are found in North America. They are cross-fertilized by butterflies and bees, and are typical insect-pollinated plants. The golden rod has a spiculated pollen (Fig. 75), 20 x 22 microns in size.

The pollen gives a positive hayfever reaction, but, not being wind-borne, can cause hayfever only on direct inhalation, or when used in large numbers for room decorations, when the pollen may fall from the flowers in sufficient

FIG. 74.—Golden rod (*Solidago canadensis*); most common of the plants unjustly accused of hayfever.

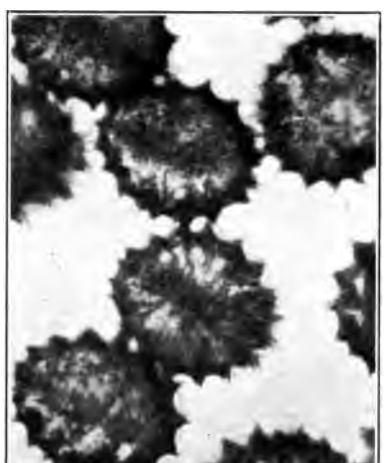

FIG. 75.—Pollen of golden rod (*Solidago canadensis*). (× 1000.)

quantities to infect the surrounding air, and thus cause a temporary reaction.

A convincing proof, however, that the golden rod is not responsible for hayfever, is the well-known fact that, in most sections, the golden rod continues to bloom for several weeks after the hayfever season is over. In western North Carolina, for instance, the hayfever season concludes about the first of October, but the Canadian golden rod (*Solidago canadensis*) brightens the autumn landscape until November. In our hayfever clinic at the Charity Hospital of New Orleans, the fall hayfever season concludes about October 26, but the golden rod continues to bloom until December.

FIG. 76.—Section of atmospheric-pollen plate, with common ragweed pollen. (× 125.)

In the atmospheric-pollen plates (Fig. 76), exposed at our laboratory during all seasons of the year, and which collect the various pollens in the air, the pollen of the golden rod is never found. Our national flower can, therefore, prove an undisputed alibi.

Roses (*Rosæ*) (Fig. 77).—These are also insect-pollinated, and could, therefore, cause hayfever only on direct inhala-

FIG. 77.—The rose. In spite of the summer hayfever being called "rose fever," the roses are harmless in hayfever.

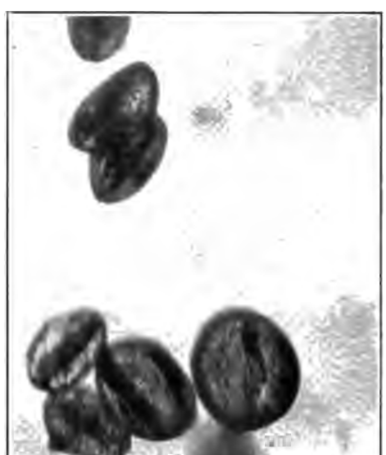

FIG. 78.—Pollen of the rose. × 500.

tion, as the pollen (Fig. 78) is never found in the atmosphere. In addition to this, their reaction is practically negative, so that, in spite of the common term applied to the early hayfever "rose cold," they are not responsible for hayfever.

Resin Weed (*Grindelia squarrosa*) (Fig. 79).—This is another falsely accused plant, whose reputation, however, is limited to the Rocky Mountain states. It is blamed in

FIG. 79.—Rosin weed (*Grindelia squarrosa*); formerly considered an important cause of hayfever in the western states, but is harmless.

Wyoming and the adjoining states for the prevalence of hayfever. Specimens of this were sent to our biological laboratory by Dr. W. A. Wyman, of the Wyoming State Board of Health. The pollen was found to be spiculated and measures 20 microns in diameter (Fig. 80), which is the size of the giant-ragweed pollen, which it resembles microscopically.

The pollen, however, like the flowers, are sticky and resin-like as implied by the popular name, and the anemophilometer[1] failed to detach any pollen. The pollen itself gives a positive reaction, but as it is not wind-pollinated, and therefore not in the atmosphere, it is not a cause of hayfever. The probability, therefore, is that the resin weed, on account of its prevalence and conspicuousness, was selected in the same manner that the golden rod has been so long held responsible for hayfever, while the real but insignificant hayfever weeds were unsuspected.

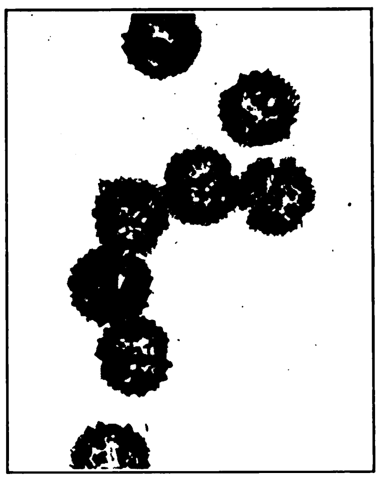

FIG. 80.—Pollen of rosin weed (*Grindelia squarrosa*). (× 500.)

Evening Primrose (*Œnothera*) (Fig. 81).—These are among our most interesting wild flowers. The large lemon-scented flowers open just before sundown and fade in the sunlight of the following day. They are fertilized by the honey bee, bumble bee and nocturnal moths. They are listed as hayfever plants in some of the older text-books, but are

[1] The anemophilometer is an instrument used in the laboratory of the American Hayfever Prevention Association to test the wind-pollination of plants.

harmless. There are about fifteen varieties in the United States and all are typical insect-pollinated flowers.

FIG. 81.—Evening primrose (*Œnothera biennis*); harmless in hayfever.

Field Daisy (*Chrysanthemum*) (Fig. 82).—The botanical name of the field daisy is *chrysanthemum*, which is Greek for "golden flower." They are the most common flower of the field and roadside, and are universal favorites for their simplicity and decorative beauty.

There are about one hundred varieties of wide geographical distribution. All are fertilized by bees and butterflies. Their pollen is never found in the air, so that they do not cause hayfever, although a reaction may result in sensitized nostrils by direct contact with the flowers.

Dandelion (*Leontodon*) (Fig. 83).—The familiar yellow flower of the dandelion is common both in the city and

Fig. 82.—Field daisy (*Chrysanthemum leucanthemum*) causes reaction only on direct inhalation.

Fig. 83.—Dandelion (*Leontodon taraxacum*) causes reaction only on direct inhalation.

country. The broad-toothed jagged edge of the leaves bear some resemblance to the teeth of the lion, hence, the name "dandelion" (*dents de lion*).

There are about twenty varieties in North and South America. All are insect-pollinated and harmless, except on direct application. Children should not apply the dandelion to the nostril as the pollen (Fig. 84) may develop a latent hayfever, which may result in sensitization to atmospheric pollens.

FIG. 84.—Pollen of dandelion (*Leontodon taraxacum*). (× 500.)

Clovers (*Trifolium*).—These and the allied alfalfas are frequently accused of being a cause of hayfever. They are harmless, however, as they are insect-pollinated. The pollen is smooth (Fig. 85) and measures 30 microns in diameter.

Sunflower (*Helianthus*).—There are about sixty species of these in the United States, including the annual and perennial forms. We receive many inquiries as to their relation to hayfever, but, as they are insect-pollinated and their pollen is therefore not in the air, they do not cause hay-

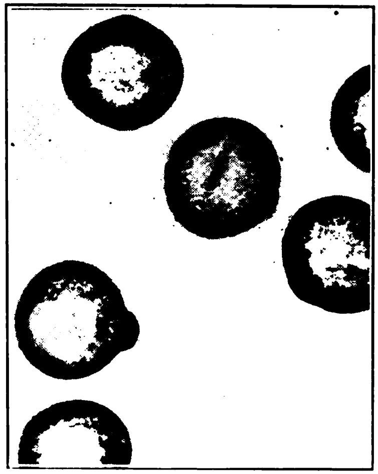

Fig. 85.—Pollen of clover (*Trifolium pratense*); harmless in hayfever. (× 500.)

Fig. 86.—Pollen of sunflower (*Helianthus annuus*) causes reaction only on direct inhalation. (× 500.)

fever except on direct application to the nostrils. As the pollen is toxic, however, persons subject to hayfever should avoid growing the tall varieties (*Helianthus annuus, lætiflorus,* etc.) in large numbers on their premises, as sufficient pollen (Fig. 86) may be shaken from the flowers to cause a hayfever reaction.

CHAPTER VII.

ANATOMY AND PHYSIOLOGY OF THE NOSE.

ANATOMY.

THE nose is composed of a framework of bones and cartilages, the inferior part having two elliptical orifices, the anterior nares, separated from each other by a septum forming the vestibules. The interior of the vestibules has a number of stiff hairs or vibrissæ, which tend to filter the inspired air from insects and other similar foreign objects. The spaces are too large, however, to offer any material protection against the inhalation of minute particles such as pollen.

The nasal cavities, or fossæ, are two large spaces of irregular shape (Fig. 87), extending from the roof of the mouth to the base of the skull, and separated from each other by a partition or septum composed of cartilage and bone. They open into the pharynx by the two posterior nares.

The roof of these cavities is formed by the nasal bones in front, the body of the sphenoid behind and the cribriform plate of the ethmoid between them. The floor is formed by the palatine process of the superior maxillæ and the palate bones.

The septum is formed by the perpendicular plate of the ethmoid above, the vomer below, the intervening space being filled by the triangular cartilage. The outer wall of the nasal fossa is formed by the superior maxillary, lacrimal, palate and sphenoid bones.

Each nasal cavity communicates with four accessory cavities or sinuses (Fig. 88); the frontal sinus above, the sphenoidal sinus behind, and the maxillary and ethmoidal

sinuses on the side. The lacrimal canal connects the nasal fossa with the eye, and the Eustachian tube, entering the pharynx just behind the nasal fossa, indirectly connects it with the middle ear.

The close relation of these parts explains the ease with which infectious processes are communicated from the nasal fossæ, and the widespread disturbance when these passages are irritated and congested by the hayfever process.

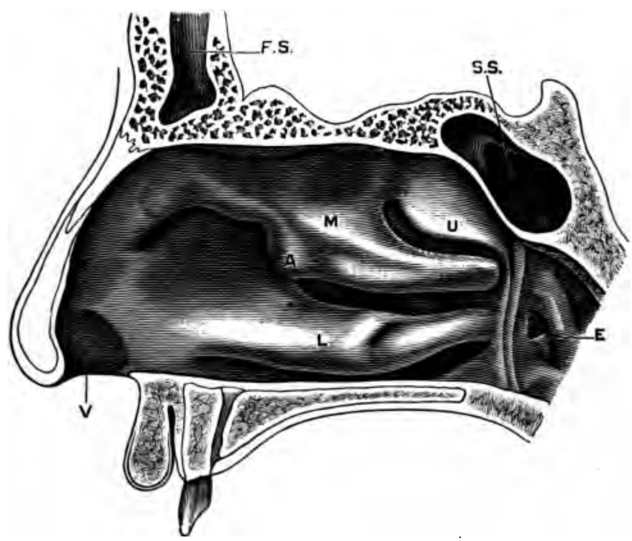

Fig. 87.—Antero-posterior section of the nose, showing the outer wall of the right nasal cavity. L. Inferior turbinate; M. Middle turbinate; A. Anterior end of middle turbinate; U. Superior turbinate; F.S. Frontal sinus; S. S. Sphenoidal sinus; E. Eustachian orifice; V. Vestibule. (Zuckerkandl).

The nasal fossæ are divided into three longitudinal passages or meatuses, formed by the three projecting bony plates arising from the sides of the nasal chambers, viz., the superior middle and inferior turbinates.

The superior turbinate is a small ridge of the outer nasal wall, projecting from the lateral wall of the ethmoid bone. The middle turbinate is a process of the ethmoid bone. It

is curled upon itself in a scroll-shaped form, and inclines backward and downward. The inferior turbinate is a thin lamella of bone, also curled upon itself, and is attached to the maxilla and palate bone. It extends almost the entire length of the nasal chamber.

The upper nasal passage, the superior meatus, lies between the superior and middle turbinates, and occupies the poste-

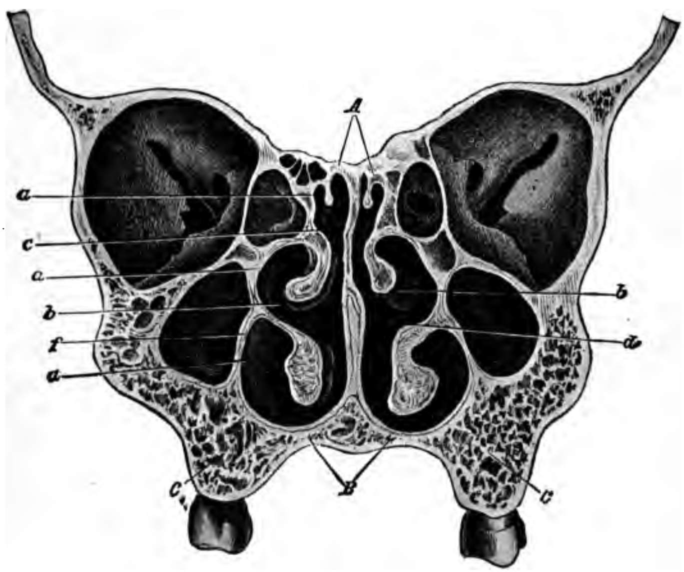

FIG. 88.—Transverse section of the head, showing the relation of the structures within the nasal cavities. *A*. Roof of nose; *B*. Floor of nose; *f*. Outer wall; *c*. Alveolar process; *a*, *a*, *a*. Superior, middle and inferior meatuses; *b*. Middle turbinate; *c*. Olfactory region; *d*. Respiratory region. (Zuckerkandl).

rior third of the nasal wall. The middle meatus lies between the middle and inferior turbinates, and occupies the posterior two-thirds of the wall. The inferior meatus extends along the whole length of the outer wall, and lies between the inferior turbinate and the floor of the nose.

The septum, which forms the partition of the nasal chambers, is inclined, in a large proportion of cases, to one

side or the other, thus enlarging one nasal fossa at the expense of the other. When this is sufficiently marked to cause serious obstruction, it is a predisposing factor in hayfever, and aggravates the symptoms in affected cases. The septum varies in thickness from $\frac{1}{10}$ inch anteriorly to $\frac{1}{8}$ posteriorly.

The nasal cavities are lined with mucous membrane, whose continuity may be traced with the conjunctiva through the nasal ducts and lacrimal canals; with the lining membrane of the middle-ear and mastoid cells, through the Eustachian tubes; and with the mucous membrane of the frontal, ethmoidal, sphenoidal and maxillary sinuses, by way of their respective meatuses.

The mucous membrane is composed of three layers, viz., the superficial, or epithelial layer; the mucous membrane proper, composed of connective and elastic tissue, muscular fibers, glands, numerous bloodvessels and nerves; and the submucous cellular tissue, by which the membrane is attached to the parts beneath.

The submucous layer is composed of fibrous and elastic tissue, and contains the vascular, lymphatic, nerve and glandular elements. The venous plexus in this layer is characterized by large cavernous sinuses capable of sudden distention, thus resembling erectile tissue, this being especially marked in the inferior turbinals. The effect of the pollen protein, in causing congestion of this erectile tissue, is a characteristic symptom of hayfever.

The mucous membrane of the vestibules contains numerous vascular papillæ, and is lined with squamous epithelium, so that it bears greater resemblance to the skin than to the mucous membrane.

In the upper part of the nasal cavities, and as low as the middle turbinal and the upper part of the septum, the superficial layer of the mucous membrane is composed of columnar epithelium, the remaining portion being of the columnar ciliated epithelium.

The ciliæ of this epithelium have the characteristic vibratory motion. This is impaired by the turgescence due to hayfever, and thus tends to the accumulation of discharges

in certain stages of this disease. The ciliary wave in the nose is toward the pharynx, and thence toward the mouth, while, in the lower respiratory passages, it is upward.

The olfactory mucous membrane, which forms the peripheral organ of smell, is located in the upper part of the nostrils. It is in the path of the current of the inspired air, so that inhaled pollen may be deposited directly upon it. The effects of hayfever, however, on the sense of smell is usually not due to the effects of the pollen protein, but to the mechanical obstruction of the lower nasal passages, which prevents the olfactory particles from reaching the olfactory membrane.

The glands in the nasal mucous membrane are mucous and serous in character, and are of the racemose type, opening by small funnel-like orifices on the surface of the membrane. The serous glands are especially stimulated in hayfever, and are responsible for the copious discharge in these cases.

The nasal cavities are richly supplied with blood, being supplied by the anterior and posterior ethmoidal, the sphenopalatine, branch of the small meningeal and alveolar arteries, these having their accompanying veins, which form a close network below the mucous membrane.

The nerve supply is from the olfactory, which is distributed over the upper third of the septum, and the superior and middle turbinates; the nasal branch of the ophthalmic, the anterior dental branch of the superior maxillary, the sphenopalatine and Vidian nerve.

The Vidian nerve is formed by the union of the greater superficial petrosal and the carotid branches, the former arising from the facial nerve and the latter from the sympathetic plexus surrounding the carotid artery. These branches unite into one nerve trunk which passes through the Vidian canal, terminating in Meckel's ganglion. The mucous membrane, therefore, obtains its general sensation through the same nerve trunk, the fifth nerve, by which vasomotor control is exercised, which is one of the causes of the reflex and general disturbance arising from the nasal absorption of the pollen protein.

The lymphatics form a very superficial network in the nasal chambers. They terminate in two trunks, which pass close to the openings of the Eustachian tubes to join glands in the lateral walls of the pharynx.

PHYSIOLOGY OF THE NOSE.

While the functions of the nose in olfaction and phonation are generally understood, its importance in preparing the inspired air for respiration is not so well recognized.

The complicated mechanism of the nose and its vascular mucous membrane, located at the place of entry of the air inspired into the throat, bronchi and lungs, is especially adapted for warming, moistening and cleansing the inspired air.

This air receives most of its heat from the turbinates, which are kept at the bodily temperature by the large underlying vascular supply. This warming is effected to such a degree, that, irrespective of the external temperature, the air in passing through the nostrils reaches approximately the temperature of the body, usually 90 to 98° F.

The moistening of the air in passing through the nostrils is effected by the tears, which have passed through the nasal ducts, the large amount of serous transudation from the nasal mucous membrane, and the secretions of the muciparous glands. This moisture may reach as high as 12 to 16 ounces daily, as demonstrated by the experiments of expert physiologists, the amount varying with the degree of humidity of the external air. The result of this nasal function is that the air is almost completely saturated with moisture before reaching the lungs.

Small particles, such as dust and pollen, are deposited on the mucous membrane, and are retained by the tenacious mucus, and with it are propelled toward the nasopharynx by the vibrations of the ciliated epithelium.

As a filter, however, the nostrils are not as perfect as their function in warming and moistening the inspired air. Dust, smoke and similar buoyant particles, frequently pass through the nostrils, and are deposited in the throat or lower

respiratory passages. Unless the amount is excessive, however, the greater quantity is lodged on the turbinals and septum, and it is on these parts that most of the pollens causing hayfever are deposited.

The air-current passes from the nostrils upward to the middle and superior meatuses, then downward and backward by the middle turbinal and the roof of the nose, and out through the posterior nares into the nasopharynx.

Sneezing is a reflex act excited by irritation of the fibers of the nasal branches of the fifth pair of cranial nerves.

An important function of the nasal mucous membrane in relation to hayfever is its permeability, which permits fluids to penetrate them from without, and become absorbed by the bloodvessels, the extent to which this may take place being regulated by the thickness of the epithelial coat.

CHAPTER VIII.

SYMPTOMS, DIAGNOSIS AND SUSCEPTIBILITY, NON-INFECTIOUSNESS, ATYPICAL FORMS.

SYMPTOMS.

THE symptoms of hayfever in the early stages resemble those of an incipient coryza, for which it is frequently mistaken. It is attended with sneezing, and congestion of the nostrils due to the swollen mucous membranes resulting from irritation of the vasodilators, and with a free serous nasal discharge from overstimulation of the parasympathetic system. Occasionally there is a slight elevation of temperature, but this, however, is frequently subnormal. There is itching of the inner canthi of the eyes and of the roof of the mouth in the region of the soft palate. The difficulty of nasal breathing, which is usually present, is aggravated when the patient is in the recumbent position, and less when exercising. Unlike an ordinary coryza, however, the discharge remains thin and serous, but may become mucopurulent toward the termination of the attack.

There is usually marked vasomotor paresis causing turgescence of the turbinates which, in many cases, is the most annoying feature of the disease. When this is present in both nostrils, which is frequently the case, especially at night, it necessitates mouth-breathing, resulting in dryness of the mouth and throat. Even when the turgescence is in one nostril only it frequently causes a distressing pressure, which is sometimes referred to the affected side of the head.

An itching sensation of the soft palate is a common symptom, which the patients usually try to relieve by rubbing with the tongue. Less common symptoms are itching of the face, especially of the nose, and of other parts of the body. Occasionally, the skin irritation may be the predominating feature in the disease, as in the case reported by

Louis Hannah,[1] in which a dermatitis was present on the body, back and limbs, which were covered by minute papules, erythema, tumefaction and vesiculation. It was associated with exposure to the ragweed pollen, responded to the intradermal test, and was relieved by the injection of the pollen extract.

There is usually considerable general depression, which is due to the abnormal temperature, the discomfort of breathing, and the effects of the absorbed pollen proteins on the system generally. Many of these cases are complicated with asthma, which increases the suffering of the patient.

Relief is experienced when the supply of pollen from any cause is diminished or disappears, as after a frost or on a sea voyage. A continued rain, by precipitating the pollen from the air, affords relief, and an absence of wind, or one blowing the pollen away from the patient, gives temporary relief.

The severity of hayfever during any particular season depends upon: (1) Climatic conditions, causing an abundance of hayfever pollen-producing plants; (2) meteorologic conditions, as the prevalence of high winds during the hayfever season, which aggravates symptoms by increasing the supply of atmospheric hayfever pollens; and (3) upon the extent to which the hayfever weeds have been destroyed. These facts have been corroborated by the records of our atmospheric-pollen plate stations.

DIAGNOSIS.

In spite of the greater increase in medical knowledge, many cases of hayfever are still mistaken for ordinary colds. The symptoms described above and their recurrence at certain periods of the year should simplify the diagnosis, which may be confirmed by the intradermal test.

Hayfever is frequently not recognized, especially in families in which there are no other members affected by the disease.

[1] Ragweed Dermatitis, Jour. Am. Med. Assn., March 22, 1919.

It is quite common to have patients report that they have suffered several seasons with the disease, until finally its periodic recurrence suggests the probability of hayfever.

Diagnostic Tests.—The diagnostic test should always be made in order to verify the diagnosis, and to determine the pollen or pollens to which the patient is sensitive. The selection of these is simplified by our classification from a biological standpoint of the principal hayfever pollens into four groups, viz.: (1) *Ambrosiaceæ* (ragweeds); (2) *Gramineæ* (grasses); (3) *Artemisia* (wormwoods); and (4) *Chenopodiaceæ* (amaranths, chenopods and docks). (See chapter XVII, The Classification of Hayfever Plants.) While these groups do not include certain hayfever pollens found in special localities, as for instance those of the mountain cedar (*Sabina sabinoida*) in northern Texas, the western cottonwood (*Populus sargentii*) in Dakota, Arizona and Nebraska, etc., still they include 90 per cent of the known hayfever pollens, and therefore greatly simplify the diagnostic tests. These are limited to the pollens to which the patient is exposed, as shown by the botanical distribution of the hayfever plants in the locality in which the patient lives (radius of 5 miles).

The *Artemisia* group, for instance, is not found in the eastern and southern states, and it is therefore unnecessary in this section to test the reaction of the patient to these pollens. The tests should, therefore, be limited to the ragweed, grasses and chenopodium groups. During the active hayfever season, the presence of the prevailing hayfever pollens is demonstrated by the atmospheric-pollen plates.

The tests of the patient's reaction to the hayfever pollens are the following: (1) Nasal, (2) ophthalmic, (3) cutaneous and (4) intradermal.

In the *nasal test* some of the pollen is applied directly to the nasal mucosa. This may be done by means of a pledget of cotton or the patient may inhale the pollen directly from the flower (inflorescence). This method is crude and should never be used during the hayfever season, as it may lower the patient's normal resistance to the pollens.

In the *ophthalmic test* a drop of pollen extract, containing 5 units[1] of the pollen extract (1 drop of the 100 units to the cc), is instilled into the conjunctival sac. The reaction is indicated by injection of the surrounding membranes. It is difficult with this test to determine the degree of the patient's susceptibility, and it is, moreover, inapplicable during the hayfever season when the patient's eyes are usually already irritated (conjunctivitis).

In the *cutaneous test* the skin of the forearm is first scarified, and the pollen extract (1 drop of the 100 or 1000 units to 1 cc) is applied. This method can be used at any season, but lacks the accuracy of the intradermal test, and is also unreliable as regards the degree of the patient's susceptibility to the pollen.

In the *intradermal test,* 5 units of the pollen extract (0.05 cc of the 100 units to 1 cc) is injected into (not under) the skin of the forearm. In positive reactions, an urticarial wheal surrounded by a circle of hyperemia, develops in fifteen minutes. The degree of sensitiveness of the patient to the pollen is indicated by the size of the wheal, which varies from 0.3 to 2.5 cm. in diameter and by the degree of the surrounding hyperemia. In most cases, two tests, as for instance of the grass and of the ragweed pollens, are made at one time, so that the reaction may be compared.

The injection should be made with the usual precautions regarding asepsis. Alcohol is used for sterilizing the skin of the patient, as the stain of iodine obscures the appearance of the reaction. In thousands of tests there has been no case of infection and no unpleasant reactions from our use of the pollen extracts.

NON-INFECTIOUSNESS.

In the search for the microbic origin of disease in general, it was also supposed that this was the case with

[1] The standard unit of pollen therapy is 0.001 mg. of pollen protein. It was first suggested by Noon, of London, and is used by the principal manufacturers of pollen extracts in the United States.

hayfever. A careful study of its etiology has shown this to be without foundation.

This being the case, hayfever is therefore not an infectious disease. This is a matter of some importance, as the physician is frequently asked regarding the communicability of hayfever, especially as it is not uncommon for several members of a family to be affected by this disease. Hayfever is a sensitization to pollen protein, and not an infection by microörganisms, which may multiply and be transmitted to others.

Many of the text-books also state that there is present in hayfever patients some neuropathic condition which makes them susceptible to hayfever. While patients, during an attack of hayfever, are usually nervous, partly owing to the constitutional effect of the disease and partly to the prolonged annoyance and irritation, a careful analysis of over 1800 patients fails to show any unusual degree of neurotic manifestations in these cases.

The statement that persons of superior education, and with the higher nervous temperament incident to modern life, are more liable to hayfever is also without foundation. It is as common among the poor and uneducated, who visit our hayfever clinic at the Charity Hospital, as it is among the educated classes. The belief that persons living in the country are not susceptible to hayfever has also been disproved by the questionnaire of the United States Public Health Service in Louisiana[1] (June, 1916), which showed that farmers were, as a class, the most frequent sufferers from hayfever.

SUSCEPTIBILITY.

If the normal equilibrium of the subject is not disturbed by the absorbed proteins of inhaled pollens, there is no clinical evidence of hayfever, although the pollens may be inhaled in large numbers. In visiting a locality in which there are large numbers of blooming hayfever plants, while

[1] Scheppegrell: Hayfever in Louisiana, New Orleans Med. and Surg. Jour., October, 1916.

the majority of persons are entirely unaware of any unusual conditions, hayfever subjects are affected in different degrees by the pollens in the air. This is also indicated by the intradermal diagnostic tests.

It is evident, therefore, that there is a wide difference in the degree of susceptibility of different individuals to the pollens. The question is—What are the limits of this susceptibility?

The difficulty in deciding this is due to the fact that specific susceptibility may exist indefinitely without developing hayfever by reason of insufficient exposure to the hayfever pollens. In order to understand this more fully we must consider the question of immunity to hayfever. As in the case of infectious diseases, it has not been definitely decided whether immunity is ever absolute or is only relative.

As an illustration that even high resistance may be overcome by great exposure, the following cases, which occurred near Hendersonville, in the mountain region of western North Carolina (elevation 2350 feet) are instructive. The natives of this section are rarely subject to hayfever; in fact, the general opinion is that they are immune. Two farm laborers, aged forty-three and twenty-five years respectively, were stripping corn for fodder during the month of September. Adjoining the field and to windward was a large quantity of ragweed (*Ambrosia elatior*), the pollen of which blew like dust over the field so that the corn was stained yellow. The same evening both men developed typical attacks of hayfever with marked symptoms, lasting forty-eight hours.

These patients evidently had so high a resistance that, until the age of forty-three and twenty-five respectively, they were considered immune, but nevertheless developed severe attacks of hayfever after this extraordinary exposure.

As a result of the variations in the degree of susceptibility, all hayfever subjects, even in the same locality, do not suffer from their attacks at the same time. Some patients with a low susceptibility have hayfever only when the pollens are in great abundance in the air, so that they

have only a few attacks during the season. Others with a high susceptibility suffer in various degrees during the whole of the pollinating season of the plants to whose pollens they are sensitive.

An attack of hayfever not only does not develop immunity, but hypersensitiveness (allergy) due to the decreased resistance, resembling in this respect the infection with such organisms as the influenza bacillus, pneumococcus, streptococcus and staphylococcus.

It is quite common that a patient, who has not previously suffered from hayfever, visits the country when there are large numbers of hayfever pollens in the air, and not only falls a victim to the disease, but develops a sensitization that afterward causes him to suffer from hayfever in the city, where heretofore he had apparently been immune. Presuming that the daily average number of pollens in the city was 25 per kiloliter of air, and in the country 60, he had formerly a resistance that could negotiate the absorption of 25 pollens per kiloliter, but, after developing hayfever from exposure to 60 pollens per kiloliter, his resistance was lowered so that 25 pollens per kiloliter are now sufficient to cause hayfever. This explains why persons of forty or more years of age sometimes develop attacks of hayfever in localities where formerly they were apparently immune.

The susceptibility of hayfever subjects varies within considerable limits, not only in the degree of the reaction, but also in their reaction to different pollens. The majority of hayfever subjects in the eastern and southern states are sensitive to the pollen of the ragweeds, and not to that of the grasses (fall hayfever). A smaller number is sensitive to the pollen of the grasses, but not to that of the ragweeds (spring hayfever). Others are sensitive to the pollens of both ragweeds and the grasses (spring-fall hayfever), while certain cases (8 per cent) are sensitive not only to these pollens but also to those of other plants and trees, so that they may suffer from hayfever attacks during the greater portion of the year (perennial form).

ATYPICAL FORMS OF SENSITIZATION.

There are also occasional atypical forms of hayfever and asthma due to the inhalation of the dandruff protein of horses and other animals. Also in which the attacks are caused by the dust protein of coffee, flour and similar material. These, in the aggregate, form but a small percentage of the total number of hayfever cases, and are usually due to preventable causes. In our series of 1000 cases there were only 7 such cases reported, or $\frac{7}{10}$ of 1 per cent. The protein of certain articles of food may also be responsible for occasional cases.

In the diagnostic tests for perennial cases of hayfever, however, the possibility of these forms of reaction should be carefully considered.

Cases due to the odors of flowers are not true hayfever, but reflex disturbances from the olfactory nerve.

CHAPTER IX.

ETIOLOGY.

EXCITING CAUSES.

THE development of hayfever at the time of the blooming of certain plants, and its disappearance with these flowers, eventually led to the conclusion that a direct relationship existed between hayfever and the blooming of these plants. This was corroborated by the fact that susceptible persons develop a paroxysm by simply approaching such plants at a time when their pollen is being dispersed by the wind. It was also found that this pollen, applied to the nostrils of susceptible subjects, could produce a hayfever reaction at any season of the year.

The reaction of hayfever is due to the effects of the absorption of the protein contents of the pollen, and the substances liberated by the proteolytic action of the patient's cells. The immunity of the patient depends upon the completeness and rapidity with which the liberated products are neutralized. The character of this process establishes the degree of susceptibility of the patient, and forms an important factor in what is called "predisposition." This is probably also affected to some extent by certain general conditions, but the influence of these has not been clearly established.

Immunity and predisposition in hayfever are relative terms. The person who is immune and the one who is affected with hayfever may both breathe the same pollen-infected air, the former without apparent discomfort and the latter developing an attack. In each case, the pollen enters the nasal cavities, but in the immune the clinical symptoms are not presented.

This result is due to the fact that all cells possess to some extent a proteolytic power which acts as a defense against

the invasion of foreign proteins, provided certain limits are not exceeded. In the case of the hayfever subject, the protein of the inhaled pollen are digested so rapidly that the liberated products act as a toxin. In the normal subject, however, in which this process takes place more slowly, the products are assimilated without disturbing the equilibrium of the subject. In addition to this, the entrance of foreign proteins by parenteral channels results in the development of antibodies, which are ferments that protect the host within

FIG. 89.—Pollen of common ragweed, with three germinating pores. (× 1000.)

certain limits. The extent to which these processes neutralize the liberated products of the pollen protein, establishes the degree of immunity of the patient.

The manner in which the dissolved extract of the pollen leaves the pollen varies in different species, depending on the formation of the external coat (extine). In the common ragweed (*Ambrosia elatior*) there are three openings or pores shown in the photomicrograph (Fig. 89), and which are intended for the emission of the germinating tubes, through which the dissolved material may escape.

In the wormwoods (*Artemisias*) this is not only the case, but the process can easily be observed under the microscope. In the photomicrograph (Fig. 90) the pores are shown, and a portion of the contents which has been ejected from these openings.

Before the severity of the reaction of the *Artemisias* was known, instead of making an extract of the pollen in our laboratory for the initial test, the ordinary pollens were applied to the nostrils of the test case. Immediately there

FIG. 90.—Pollen of wormwood, showing contents ejected from germinating pores. (× 1250.)

was a violent reaction which lasted over twenty-four hours. As these pollens are not spiculated, in which case we sometimes have a rapid primary reaction, this prompt reaction was difficult to understand until the test was made under the microscope. It was then found that the injection of a warm, normal saline solution was immediately followed by the ejection from one, two or three pores of the pollen, a portion of its contents as shown in the photomicrograph, and which, in view of the active character of its contents, explained the rapidity of the primary reaction.

In the sedges the extine is usually dense so that the extract escapes with difficulty. This is probably the reason for the inertness of the sedge pollen in hayfever. The grasses, on the contrary, although botanically closely allied to the sedges, have an extine of remarkable porosity, and they all furnish a marked hayfever reaction in susceptible subjects.

FIG. 91.—Pollen of okra, with germinating tubes. (× 200.)

It was at one time supposed that some portion of the nasal reaction in hayfever was due to the development and action of the germinating tube of the pollen.

This development of the germinating tube or tubes is essential to the function of fertilization, which is the primary object of the pollen. In the photomicrograph (Fig. 91) there is shown the pollen of the okra (*Hibiscus esculentus*), which we dissected from the stigma of the flower. The germinating tubes appear in three stages. Fig. 92 shows the pollen of the careless weed (*Amaranthus spinosus*), containing a single tube. This specimen was found on an atmospheric-pollen plate, the pollen apparently having been blown from the stigma of the plant.

FIG. 92.—Pollen of spiny amaranth (*Amaranthus spinosus*), with germinating tube. (× 1000.)

The development of these tubes is always a slow process, and could in no way explain the hayfever reaction which always develops within a half hour and frequently almost immediately. A conclusive proof, however, is that in the microscopic examination of the hayfever secretions made at our biological laboratory, in which hundreds of pollens were examined, no case of a pollen with a developed germinating tube was found.

PREDISPOSING CAUSES.

Local conditions, such as abnormalities of the nasal passages may act as a predisposing cause. The majority of hayfever cases, however, that we have examined, both in our hayfever clinic and in private practice, are without unusual abnormalities. Marked deviation of the septum and other irregularities, causing a condensation of inhaled pollen in one part of the nostrils, favor a continuation of the hayfever and should be corrected.

The increased susceptibility of hayfever after an initial attack is due to the sensitized condition resulting from the absorption of the pollen protein by parenteral channels. The antibodies resulting from this reaction are probably of the anaphylactic type, which favor a reduced resistance to further sensitization.

Anti-anaphylaxis, eventually resulting in a reactive condition of immunity, sometimes also develops in hayfever, but is usually delayed for a period of many years (twenty to thirty) and is indicated by gradual decrease of the paroxysms. This should not be confused with the disappearance of the attacks due to diminution of the supply of pollen resulting from a change of residence, or the eradication of the pollinating weeds.

The effects of hayfever are due not only to the absorbed pollen proteins but also to the action of pathogenic microorganisms resulting from the lowered resistance of the nasal mucous membranes to microbic infection, and from the inflammatory reactions associated with these processes. In the treatment, these various conditions should be considered.

The variations in the intensity of hayfever appear conflicting until they are checked by the records of the atmospheric-pollen plates. It is then observed that there is a direct relationship between the number of atmospheric pollens, registered by these plates, and the severity of the patient's symptoms. With a mild wind (5 or 6 miles per hour), only a small amount of pollen is distributed in the

air, and most hayfever subjects suffer little inconvenience. In cases in which the susceptibility is not marked, no attack whatever may develop.

If the wind becomes high (15 or more miles per hour), large amounts of pollen are carried into the air, and increase the infestation both for distance and the number of pollens. All hayfever subjects within the affected area now develop more or less severe symptoms, which persist for some time after the atmospheric disturbances subsides. Our records show that the pollen count remains high for ten to twenty hours after such high winds have subsided.

During a rain the pollen is precipitated, and the patient is relieved as soon as he overcomes the effects of the pollen already inhaled, and the effects of the increased humidity. The attacks recur, however, as soon as the pollen again infects the atmosphere.

When the pollinating season of the hayfever plants is coming to a close, the pollen count gradually lowers, and also the symptoms of hayfever. When the noxious pollen disappears from the air, all symptoms of active hayfever also subside. So closely is the pollen count related to the symptoms of the hayfever cases, that their condition may be accurately predicted by simply watching the pollenometric records.

THE ONSET OF THE ATTACK.

The onset of the annual attack of hayfever depends upon wind conditions. After the ragweed, for instance, has commenced to pollinate, patients susceptible to this pollen will feel only slight discomfort as long as the wind velocity is so low that only small amounts of pollen are carried into the air. Whenever the wind velocity becomes high, however (15 or more miles per hour), large quantities of pollen are carried into the air and, being inhaled by the patients, the attacks become proportionately severe. The uniform manner in which these severe paroxysms develop in patients living in the same locality is very striking. Should a high wind arise shortly after the first pollination of the ragweeds,

the cases of hayfever, instead of developing gradually, at once reach a high state of severity.[1]

In the vicinity of New Orleans, for instance, the ragweed usually begins to pollinate about August 1, and on August 10 the pollens are in sufficient number in the air to appear on the exposed atmospheric-pollen plates. In 1916 the number gradually increased until, on August 20, it had reached 22 ragweed pollens per square yard of air, with only a few reports of autumnal hayfever cases, these being from subjects living in close proximity to these weeds. On August 21 the wind acquired a velocity of 23 miles an hour, and the pollen rose to 273 per square yard of air. The largest number of patients who had autumnal hayfever during that season suffered their first attack within a few hours of this rise in the pollen count. The simultaneous development of hayfever in these cases was, therefore, not psychical, as has been charged, but due to the uniform distribution of the exciting cause.

HEREDITY IN HAYFEVER.

The influence of heredity in hayfever has been the subject of considerable discussion, most writers, however, admitting its effect. In order to determine this relation we have made analysis of a series of 1000 cases treated in the hayfever clinic of the Charity Hospital and in private practice. This shows that over one-third of the cases (37 per cent) had relatives of the first degree (father, mother, sister, or brother), who suffered from hayfever.

The exact proportion, however, is probably higher than this, as specific susceptibility may exist indefinitely without developing hayfever, by reason of insufficient exposure to the hayfever pollens.

In order to understand this more clearly we must consider the question of immunity to hayfever. As in the case of infectious diseases, it has not been definitely decided whether immunity is ever absolute or is only relative. The fact that

[1] Scheppegrell: Hayfever in Louisiana, New Orleans Med. and Surg. Jour., October, 1916.

26 per cent of the cases of this series developed hayfever as late as from forty to fifty years, and 8 per cent between forty and fifty years, would indicate that this is relative at least in many cases.

In order to understand the development of hayfever at a late age, we must remember that one attack of hayfever lowers the relative immunity of the patient to hayfever, not only for an indefinite period, but probably also, unless artificially raised, for the remainder of his life.

This principle is illustrated by the following case, which is one of many similar cases: This patient had lived in Louisiana for forty-two years without developing hayfever, although his brother suffered from this disease. Fifteen years ago he spent a summer in western North Carolina and developed hayfever. He returned to Louisiana, but has continued to have hayfever every fall since this visit.

The explanation of this is that there is almost twice as much atmospheric ragweed pollen in western North Carolina as in Louisiana during the month of September, as shown by our pollenometric records. Assuming that this patient's relative immunity was 50 per cent, this was not sufficient to resist the exposure to the large amount of pollen inhaled during his visit to North Carolina. The attack, however, lowered his resistance to probably 35 per cent relative immunity. This was no longer sufficient to resist his exposure to the atmospheric ragweed pollen in Louisiana, so that he continued to suffer from hayfever.

It is not necessary to travel any considerable distance to lower the relative immunity as in this instance. One of our patients, a woman, aged forty years, lived for one season in a suburb of New Orleans, where there was a large quantity of wild grass, and developed hayfever of the grass-pollen form. The following year she moved back to the central portion of the city, where formerly she had been without hayfever, but nevertheless continued to have attacks each season. In this case also, the patient's relative immunity had been lowered by the first season's attack, resulting from greater exposure to the grass pollens.

HAYFEVER AND ASTHMA.

The tendency of hayfever to develop asthma is well known. It is usually a later complication, although sometimes it is the first and, occasionally, the only symptom of this disease. In the series of 1000 cases, 43 per cent suffered from asthma during some portion of the season. Although this is a higher ratio than has been heretofore recognized in hayfever, the probability is that the proportion is still higher. There are many cases in which the nasal symptoms of hayfever are so mild and of such short duration, that the patient recognizes only the asthma from which he is suffering. In addition to this, there are also cases of asthma, due to pollen sensitization, in which the nasal symptoms are apparently entirely absent, and therefore its relation to hayfever unrecognized.

In view of this, all cases of asthma, especially those occurring during the usual hayfever season, should be tested with the extracts of the atmospheric pollens to which the patient is exposed. Our experience has shown that the number of asthmatic patients giving positive reactions to the pollens, especially of the grasses, chenopods and ragweeds, is quite high. This diagnostic test is, therefore, important, especially in view of our experience that these cases not only responded favorably to the immunizing hayfever therapy, but that the number of seasonal cures and improvements equals those of the uncomplicated form of hayfever.

CHAPTER X.

HAYFEVER SEASONS—PERCENTAGE OF CASES. PROPORTION OF EARLY AND FALL HAYFEVER.

THE SEASONS IN HAYFEVER.

WHILE the fall hayfever, which in the eastern and southern states is principally due to the ragweeds (*Ambrosiaceæ*), is the most common and important, there are forms of hayfever occurring at other seasons, as for instance, that due to the grass (*Gramineæ*) pollen, which is prevalent in May, June and July. In some localities we have hayfever even in the winter, due to trees and plants in bloom at that time, such as the cedar (*Juniperus*), false wormwood (*Parthenium hysterophorus*), etc. Hayfever, therefore, is a disease that may develop at any season of the year that noxious pollens are found in the air.

A popular fallacy, frequently referred to in works on hayfever, is that this disease is uncommon below the thirty-fifth parallel of latitude. South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, half of Arkansas, and most of Texas, are south of this parallel, but the ratio of hayfever cases to the population differs but little in these states from that between the thirty-fifth and forty-fifth parallel.

The development of hayfever in any locality depends upon the atmospheric hayfever pollens increasing to a point which overcomes the resistance or relative immunity of the patient. This has been confirmed by the atmospheric-pollen plates, which have been exposed by our research department in various sections. It was ascertained that most of the cases of fall hayfever were due to the pollen of the ragweeds, and that the spring and summer cases are

caused by the pollen of the grasses (*Gramineæ*), although the pollen of other plants, such as the yellow dock (*Rumex crispus*), amaranth (*Amaranthus spinosus*), goosefoot (p. 128) (*Chenopodium anthelminticum*), etc., may cause the attack, or tend to maintain it when due to the grass pollens.

FIG. 93.—Pollinating grasses; the principal cause of spring hayfever.

Cases of spring-summer hayfever, which are caused by the grasses, (Fig. 93) are, in the majority of cases, not only milder in character than those caused by the ragweeds, but are easier to prevent. The size of the grass pollen is

relatively large (average 40 microns in diameter), being frequently twenty times larger than the common ragweed pollen (Fig. 94) (15 microns in diameter). On this account, the grass pollens are carried a much shorter distance by the wind, and rarely remain long in the atmosphere. Municipal efforts, therefore, for its control have every prospect of success, as illustrated in New Orleans, in which the enforcement of the Grass-Weeds Ordinance resulted in a 50 per cent reduction of the vernal hayfever.

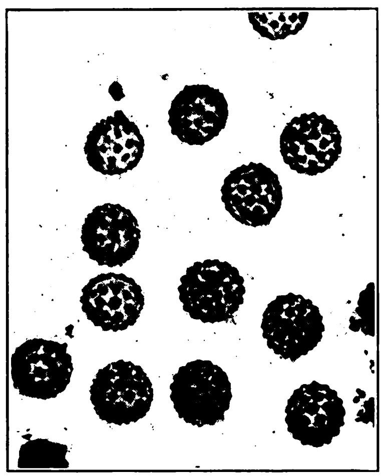

FIG. 94.—Pollen of common ragweed (*Ambrosia elatior*) on atmospheric-pollen plate. (× 500.)

The greater buoyancy of the common ragweed pollen is an important factor in the prevalence of fall hayfever. This weed does not grow within five miles of the residential section of New Orleans, being replaced by the giant ragweed (*Ambrosia trifida*). During the prevalence of a high wind, however, the number of common ragweed pollens exceeds that of the giant ragweed, whose greater size (20 microns) reduces their potential area. Another important feature is that for several days after a high wind there is little difference in the number of common ragweed pollen per kiloliter

near the ground (biological laboratory—10 feet) and an altitude of 100 feet (eighth floor of office building and tower of Loyola University, New Orleans) or of 400 feet (tower of Hibernia Bank Building).

HAYFEVER SEASONS IN THE UNITED STATES.

	Spring and Summer form.	Autumn form.
Alabama	April 15 to July 15	Aug. 18 to Oct. 10
Arkansas	June 10 to July 15	Aug. 10 to Sept. 17
Arizona	May 5 to June 5	July 15 to Oct. 1
California	May 5 to July 5	July 15 to Sept. 10
Colorado	May 10 to July 1	July 20 to Sept. 15
Connecticut	June 1 to July 15	Aug. 17 to Oct. 1
Delaware	May 5 to July 10	Aug. 13 to Sept. 20
Florida	May 1 to July 10	Aug. 18 to Oct. 10
Georgia	May 10 to July 5	Aug. 18 to Oct. 4
Idaho	May 5 to June 10	Aug. 1 to Sept. 15
Illinois	June 10 to July 20	Aug. 15 to Sept. 20
Indiana	June 5 to July 15	Aug. 17 to Sept. 25
Iowa	June 2 to July 16	Aug. 13 to Sept. 27
Kansas	May 16 to July 15	Aug. 16 to Sept. 28
Kentucky	June 1 to July 18	Aug. 15 to Oct. 1
Louisiana	May 5 to July 25	Aug. 20 to Oct. 16
Maine	June 5 to July 10	Aug. 17 to Sept. 24
Maryland	May 15 to July 10	Aug. 16 to Oct. 1
Massachusetts	June 5 to July 18	Aug. 13 to Sept. 25
Michigan	June 8 to July 15	Aug. 15 to Sept. 25
Minnesota	June 5 to July 19	Aug. 14 to Sept. 26
Mississippi	May 10 to July 10	Aug. 18 to Oct. 15
Missouri	May 10 to July 26	Aug. 12 to Sept. 24
Montana	May 15 to July 15	Aug. 5 to Sept. 15
Nebraska	May 15 to July 15	Aug. 8 to Sept. 18
Nevada	May 1 to July 15	Aug. 12 to Sept. 15
New Jersey	June 10 to July 24	Aug. 17 to Sept. 28
New Hampshire	June 10 to July 16	Aug. 16 to Oct. 1
New Mexico	May 3 to July 5	July 12 to Sept. 28
New York	June 5 to July 19	Aug. 16 to Sept. 28
North Carolina	May 15 to June 20	Aug. 20 to Oct. 5
North Dakota	May 20 to July 15	Aug. 10 to Sept. 15
Ohio	May 28 to July 13	Aug. 13 to Sept. 15
Oklahoma	May 10 to June 24	July 25 to Oct. 1
Oregon	April 25 to May 29	July 1 to Sept. 1
Pennsylvania	June 3 to July 24	Aug. 16 to Sept. 27
Rhode Island	June 8 to July 22	Aug. 15 to Sept. 26
South Carolina	May 10 to July 5	Aug. 18 to Oct. 10
South Dakota	May 13 to July 10	Aug. 8 to Sept. 22
Tennessee	June 5 to July 22	Aug. 15 to Oct. 5
Texas	May 15 to July 15	Aug. 5 to Sept. 15
Vermont	June 10 to July 22	Aug. 14 to Sept. 24
Virginia	May 15 to June 29	Aug. 18 to Oct. 3
Washington	June 12 to July 1	July 5 to Oct. 7

The etiological relation of the ragweeds, as the exciting cause of autumn hayfever is clearly demonstrated. The development, increase, decrease and final disappearance of hayfever bears a definite ratio to the atmospheric-pollen count of the ragweeds. When these pollens have practically disappeared (one to two pollen per 1 sq. cm.), all reports show that the hayfever season is over.

The table on page 123 gives the approximate dates of the development of spring and summer, and of autumn hayfever. These have been obtained from the most reliable source available in each state, and the dates are based on an average period for several years.

In any locality the development of hayfever may be delayed by rains which prevent the spread of the pollen; or it may be advanced several days by weather conditions accelerating the growth and pollination of the hayfever weeds. An early frost may also shorten the autumn form.

PERCENTAGE OF HAYFEVER CASES.

Although sufficient data had been obtained from many sections to give an approximate idea of the proportion of hayfever cases to the population, no definite information was available until the United States Public Health Service[1] sent out a list of questions regarding hayfever to all physicians of Louisiana. The result of the questionnaire, which was made at the request of the American Hayfever Prevention Association, coincided closely with the estimated average proportion of hayfever cases, viz., 1 per cent of the population. This ratio sometimes varies in different parts of the same state, owing to the prevalence of different hayfever weeds, which is influenced by climatic conditions and altitudes.

High altitudes, unless these are greater than 6000 feet, are without the important influence that has often been ascribed to them. In the section of the Allegheny range of

[1] Scheppegrell: Hayfever in Louisiana, New Orleans Med. and Surg. Jour., October, 1916.

mountains, for instance, hayfever is not only found, but is remarkably prevalent up to an altitude of 5000 feet. Even at this high level the common ragweed is frequently found in the section east of Kansas. In the Rocky Mountain and Pacific states, in which the common ragweed is rare, the sage wormwood (*Artemisia frigida*) is found at altitudes as great as 5000 feet and is a common cause of hayfever.

The answers of the questionnaire of the United States Public Health Service show that the proportion of hayfever cases in northern Louisiana was eighth-ninths of 1 per cent, and in southern Louisiana 1 per cent, or an average of 0.94 per cent, for the state. This varies but slightly from the estimated proportion north of the thirty-fifth parallel, which averages 1 per cent.

The principal weeds that cause hayfever are largely parasites of agriculture. This is especially the case with the common ragweed, the seeds of which are disseminated in land recently brought under cultivation by means of grains, hay and cattle. On this account, while hayfever is uncommon where there are extensive forests, it quickly develops where these are replaced by cultivated lands.

Although many of the trees are wind-pollinated, they are usually only of local importance. The pines (*Pinus*) generate enormous quantities of pollen (Fig. 11), which, however, are negative in hayfever.

The cottonwoods (*Populus sargentii, angustifolia, deltoides,* etc.), however, have pollen which is quite active and are a cause of hayfever in sections where they are found in large numbers. Of course, only the male (staminate) cottonwoods should be considered in this connection, as the female trees do not generate pollen. The black walnut (*Juglans nigra*) also generates a pollen which is an active cause of hayfever. This should be carefully considered in the selection of these for shade trees.

We have also found the cedars to be responsible for hayfever. In January, 1917, Dr. S. N. Key, of Austin, Texas, reported an outbreak of hayfever. On examining the atmospheric-pollen plates, which he exposed at our request, we found large numbers of pollen which were identified as those

of the mountain cedar (*Juniperus sabinoida*). The cedars were pollinating fully at this time, and the biological test gave a positive reaction for hayfever.

PROPORTION OF EARLY AND AUTUMNAL HAYFEVER.

The proportion of the spring and autumnal hayfever in 1000 cases (series C, D and E) was 7 and 38 per cent respectively, but the number of cases of the combined form (spring-autumn) was unexpectedly high, being 42 per cent, or higher than the simple autumnal form. This differs materially from the previously published reports on this subject. In many of these cases, the early hayfever is of only one to three weeks' duration, and is so much milder than the fall variety that many patients do not refer to it except on being closely questioned. The perennial form of hayfever, in which the paroxysms may develop at any season of the year, showing a susceptibility to many forms of hayfever pollens, was also higher than was anticipated, being 7 per cent of all cases. The perennial form of hayfever is more common in the southern states, on account of the mildness of the climate. This permits the growth of vegetation even in winter, so that some form of pollen is usually present in the air during every month of the year.

A noteworthy feature observed in the combined form of hayfever, is that many patients commenced with the fall hayfever and, after two or more years, gradually also acquired the spring form, and *vice versa*. This indicates that hypersensitiveness to one form of pollen predisposes to hypersensitiveness to other pollens.

The proportion of the various forms of hayfever corresponded with the diagnostic test made in these cases. This test consists in the intradermal injection of 5 units of a pollen extract (100 units to 1 c c) into the forearm of the patient. Formerly this test was made by scarifying the skin and applying the pollen extract, but this has been abandoned for the intradermal injection, which is not only more reliable, but enables the quantitative effect of the pollen to be noted.

The results of these were as follows:

PROPORTION OF CASES WHICH GAVE A POSITIVE TEST.

Grass pollen only	7 per cent
Ragweed pollen only	38 "
Both grass and ragweed pollen	55 "

A number of these also reacted to the chenopodium class of pollens (dock, amaranths, chenopodium, Russian thistle, water-hemp, etc.), especially among the patients suffering from the combined spring-autumn and the perennial forms.

The *Artemisia* (wormwood) pollen extract was also tested in a number of cases, some of which gave a positive reaction. As, however, persons living in the states east of the one-hundredth meridian are not exposed to the pollen of these plants, which are prevalent in the Pacific and Rocky Mountain states, these tests were only of scientific interest in these cases.

On the gulf coast, and in some sections of the Pacific states, the giant ragweed (*Ambrosia trifida*) is most common. Its greater size (20 microns in diameter, or twice the volume and weight of that of the common ragweed) reduces its potential radius to one-sixteenth of that of the common ragweed. Its hayfever reaction, however, is identical with that of the common ragweed, so that there is no distinction from the hayfever from this source.

In the Rocky Mountain and Pacific states, autumnal hayfever is caused by the wormwoods (*Artemisias*), marsh elders (*Ivas*), western ragweed (*Ambrosia psilostachya*) and false ragweed (*Gærtnerias*), which, however, are not as ubiquitous as the common ragweed (*Ambrosia elatior*) east of Kansas. The larger size of their pollens also diminishes their buoyancy and correspondingly restricts their potential area.

Most of the causes of spring and summer hayfever are due to the pollen of the grasses (*Gramineæ*), this being confirmed by the records of our atmospheric-pollen plates. While corn and rye belong to this family, the size of their

pollens, especially of corn (Fig. 95), prevents them from causing hayfever except in proximity to such crops.

A small proportion of spring and summer hayfever cases are caused by other pollens, such as the dock (*Rumex crispus*

FIG. 95.—Pollen of corn; its large size limits its potential area. (× 500.)

and *obtusifolius*), goosefoot (*Chenopodium anthelminticum* and *album*), water-hemp (*Acnida tamarascina*), etc., but these are usually responsible only for aggravating cases which have already been caused by the grass pollens.

CHAPTER XI.

INFLUENCE OF SEX, AGE, OCCUPATION AND RACE IN HAYFEVER.

RELATIVE PROPORTION OF THE SEXES.

In order to ascertain the influence of sex and age in hayfever, our clinical charts record the sex of the patients, the age, the approximate date of the beginning of the hayfever attacks, and the duration of the disease. This data, in addition to the results of the questionnaire on hayfever made in Louisiana by the United States Public Health Service, in 1916, gives interesting information on this subject.

In the cases of series C, D and E (1000 cases) 44 per cent were male and 56 per cent female. In the questionnaire of the United States Public Health Service it was shown that 63 per cent of the cases of hayfever were males and 37 per cent females. The discrepancy in these percentages is due to the fact that women usually have more leisure than men to have chronic diseases treated. This applies especially to the poor, as shown by the fact that the percentage of females was relatively higher in our hayfever clinic than in cases treated in private practice.

THE AGES OF HAYFEVER CASES.

The ages of hayfever patients in this series vary from six to sixty-four years, the general average being thirty-four years. The decades were distributed as follows:

1 and 10 years	2 per cent
10 and 20 "	12 "
20 and 30 "	21 "
30 and 40 "	33 "
40 and 50 "	17 "
50 and 60 "	12 "
60 and 70 "	3 "

AGE OF DEVELOPMENT OF HAYFEVER.

The age of which hayfever developed in these cases varied from four years (1 case) to fifty-nine years, the average being twenty-seven years. The ages were distributed as follows:

Percentage of cases which developed between the age of:

1 and 10 years	5 per cent
10 and 20 "	19 "
20 and 30 "	33 "
30 and 40 "	30 "
40 and 50 "	10 "
50 and 60 "	3 "

This indicates that the most common period for the development of hayfever is between the ages of twenty and forty years (64 per cent). It corresponds closely with our former report, based on the questionnaire of the United States Public Health Service in Louisiana, in which 62 per cent of the cases were found to be between the ages of twenty and forty years.

DURATION OF HAYFEVER.

The duration of hayfever in these cases varied from one month to forty-six years, the general average being nine and seven-tenths years. The duration is divided as follows:

Percentage of cases which lasted from:

1 and 5 years	50 per cent
5 and 10 "	23 "
10 and 20 "	16 "
20 and 30 "	7 "
30 and 40 "	3 "
40 and 50 "	1 "

The question of the development of an acquired immunity from continued exposure to the specific pollens is hard to determine, as it is difficult to eliminate the question of decreased exposure. If a patient moves to a locality in which the pollen exposure is below his relative immunity, he will not suffer from hayfever. This may also happen, without changing his residence, by the reduction of the weeds in his

vicinity, so as to reduce the number of atmospheric-pollens below his degree of relative immunity.

A number of cases have been recorded in which immunity gradually developed without change of exposure. That the natural development of immunity is a slow process, however, is indicated by the records, which show that 50 per cent of the cases had suffered for over ten years, 12 per cent over twenty years, and 4 per cent over thirty years.

OCCUPATIONS OF HAYFEVER SUBJECTS.

It is commonly supposed that persons in the country suffer little from hayfever, and the alleged fact that farmers are not affected is often used as an argument against the pollen theory of hayfever. Our investigations, however, have shown that the occupation which has the largest number of hayfever cases (38 per cent) in Louisiana, is that of the farmer. As they are the most exposed to the pollens, this is only natural, and shows that the greater resistance due to their outdoor life is offset by the greater exposure.

Although professional men are supposed to be especially prone to hayfever, this was found not to be the case, as they represent only 6 per cent of the cases. Next to the farmers, the greatest number of cases was in persons with indoor occupations (29 per cent), those with outdoor occupations being 19 per cent.

PROPORTION OF WHITE AND COLORED HAYFEVER CASES.

Many reports and works on hayfever refer to its rarity in the colored race. Our records in Louisiana, however, show that the proportion of white and colored are 79 and 21 per cent respectively. As the United States Census (1920) states that there were 700,256 colored and 1,096,611 white persons in Louisiana, this indicates that the colored are affected with hayfever about one-third as often as the white.

CHAPTER XII.

HAYFEVER POLLENS AND THEIR REACTIONS.

ARTIFICIAL HAYFEVER.

THE reaction of hayfever, in no way differing from the normal attack at the usual season except that the length and degree of the reaction is under control, may be artificially produced at any time. In the biological laboratory of the American Hayfever Prevention Association, pollen of all the most important hayfever plants are kept in stock, so that the effect of the various hayfever pollens may be accurately compared.

In producing an artificial attack of hayfever, it should be understood that the pollens are the male elements of *Phænogamous*, or flowering plants, and are, therefore, incapable of reproduction in the nostrils or tissues of hayfever subjects, differing in this way from infection by bacterial microörganisms. On this account, an artificially produced attack depends upon the amount and strength of the pollens used, or their extracts, and the susceptibility of the subject, and if the reaction is developed outside of the usual hayfever season of the subject when there are no noxious pollens in the atmosphere, the length and degree of the attack may be accurately controlled.

This explanation is made in view of the repeated inquiry as to whether an artificially produced reaction will not result in an attack of hayfever of indefinite duration. That this is not the case is easily seen when the nature of this process is understood.

REACTION FROM HAYFEVER POLLENS.

The rapidity and degree of the initial effect of pollen inhalation, independent of the susceptibility of the patient,

varies considerably with different pollens. With the grass pollens (*Gramineæ*) the reaction is usually slow and is frequently delayed for five to ten minutes. With the pollen of the ragweeds (*Ambrosias*) the effect is much more rapid, and usually appears in from two to five minutes. With the pollen of the wormwoods (*Artemisias*), however, which are the common hayfever plants of the Rocky Mountain and Pacific states, the effect is almost immediate and very active.

FIG. 96.—Nasal secretion of hayfever patient, with ragweed pollen and sodium chloride crystals. (× 200.)

The reaction from the inhalation of hayfever pollens is influenced by the sensitivity of the nasal mucosa of the patient. In some cases it results in an intumescence of the nasal mucosa, which causes occlusion of the nostril and

retention of the pollens, thus favoring absorption of their contents. In others it causes a free discharge of a secretion which contains but few mucous corpuscles but the usual salts of the nasal secretion. Many patients present both forms, and paroxysmal sneezing is a common symptom.

The bacteriological examination of a succession of hayfever cases showed the following bacteria in various proportions: Micrococcus catarrhalis, Bacillus Friedländer, pneumococcus, streptococcus, Staphylococcus aureus and albus.

In the treatment of hayfever the knowledge of this bacterial flora is of importance, as they are employed in the preparation of the vaccines used in acute exacerbations, in cases in which the autogenous vaccines are not available.

In a large proportion of cases, if the examination is made of the nasal discharge in the morning after the secretion has accumulated during the night, the pollen may be found (Fig. 96). That the cause of the reaction in the protein contents of the pollens is demonstrated by the fact that the aqueous extract of pollens, containing the protein, produces a reaction in hayfever subjects similar to the pollens themselves.

HAYFEVER POLLENS.

While pollens are generated by all the members of the flowering plants, only those which are wind-pollinated need be considered in connection with hayfever. While there are many plants whose pollens may cause the hayfever reaction when applied to the nostrils, only pollens which float in the air and can reach the nostrils in the course of normal respiration are responsible for true hayfever. In the selection of hayfever plants it is, therefore, important first to decide that they are wind-pollinated,[1] as the pollen of these only are found in the air.

As a rule, this may usually be inferred from the appearance of the plant. Attractive flowers and agreeable odors are

[1] The anemophilometer, an instrument for testing the wind-pollination of plants has been devised by the research department of the American Hayfever Prevention Association (Wm. Scheppegrell, M.D., Scientific American, October, 1916).

characteristic of insect-pollinated plants, and the presence of these, as in the case of the roses, lilies and golden rods, is usually sufficient to eliminate them from the list of wind-pollinated plants.

The absence of these qualities is characteristic of hayfever weeds, as in the case of the ragweeds (*Ambrosias*), wormwoods (*Artemisias*), cockle burs (*Xanthiums*) and the grasses (*Gramineæ*).

The omission of limiting the classification of hayfever plants to those that are anemophilous, or wind-pollinated, has resulted in the inclusion of many plants which are entirely harmless from a practical standpoint. In spite of the clearness of this principle, we are constantly receiving lists of hayfever weeds from all parts of the United States, which includes the roses, golden rods, resin-weeds and other insect-pollinated plants.[1]

The Pollens of Spring Hayfever.—From a test of many hundreds of pollens in our biological laboratory, the principal hayfever plants have been selected. For the early type of hayfever the chief causes are the grasses (*Gramineæ*), the special varieties varying according to climatic conditions. This applies to all portions of the United States. The spring cases of hayfever are also influenced by other wind-pollinated plants such as the amaranths (*Amaranthus*), docks (*Rumex*) and chenopods (*Chenopodium*), which, however, in the aggregate are of much less importance, both from the standpoint of reaction and geographical distribution. In some localities, the tree pollens are also responsible for early hayfever.

The Pollens of Fall Hayfever.—The fall hayfever, east of Kansas, is caused principally by the common ragweeds (*Ambrosia elatior*), this being replaced in moist regions by the giant ragweed (*Ambrosia trifida*). These cases may also be affected by the pollen of the marsh elder (*Iva ciliata*) and cockle bur (*Xanthium canadensis*), these, however, being

[1] Even in technical books published in the last two or three years, such plants as the evening primrose, chrysanthemum, aster, lily of the valley, honeysuckle and other insect-pollinated plants are described as furnishing the toxic pollens of hayfever.

of minor importance. The Russian thistle (*Salsola pestifer*) is also a common hayfever weed in some states.

In the Pacific and Rocky Mountain states the common and giant ragweeds are replaced by the wormwoods (*Artemisias*), the rough bur elder (*Iva xanthiifolia*), the sand burs (*Gærtnerias*) and the western ragweed (*Ambrosia psilostachya*).

Atmospheric-pollen Plates.—Atmospheric-pollen plates are prepared by applying a thin layer of glycerin to the central square inch (25 sq. mm.) of an ordinary microscopic slide. We have tested various combinations, but found the pure glycerin, thoroughly applied to the glass which has been previously cleansed with alcohol, to be the most practical. In extremely moist weather, when the glycerin deliquesces too rapidly, we substitute a layer of boiled linseed oil.

We have tried various forms of apparatus for the purpose of having these plates always at right angles to the direction of the wind. While this furnishes useful statistical data, the complicated construction gives it a limited range. For practical purposes the atmospheric-pollen plates are simply exposed to the wind at the residence of the patient or at the special stations.

After twenty-four hours' exposure, these plates are examined by the microscope with the aid of the mechanical stage, so that the whole surface can be traversed. A low power (125 diameters) is sufficient for traversing the slide, and when a pollen is found, a high power (500 diameters) is used for its identification.

By the injection of a drop of Lugol's iodine solution, the examination is simplified, as the grass pollens, which are stained blue-black can be easily distinguished from other pollens which are usually brown.

After the pollens have been counted they are proportioned to the number per square centimeter, as our unit is the number of pollens per square centimeter for twenty-four hours.

As the object of the pollenometric records is to determine the amount of pollen in the air, a working formula has been prepared by means of which the number of pollen per cubic yard or kiloliter of air may be determined from these plates.

Number of Pollen in the Air.[1]—The number of pollen dropping on a given surface, *e. g.*, a plate, depends only on the number of pollen per unit volume of the air, and the velocity of fall of the pollen grains.

This means that unless the plate is inclined at an appreciable angle, *e. g.*, 15 or 20 degrees, with the direction of the wind near the plate, the number of pollens dropping on the plate is independent of the wind velocity, other factors such as the number of pollens per unit volume of air, being constant. The number of pollen in the air, however, bears a direct relation to the velocity of the wind.

If the pollen grains fall with a velocity v feet per second, and there are in the air n per cubic yard, the total number N falling on a square centimeter in t hours is given by the formula

$$N = 0.143 \times n \times v \times t$$

$$n = \frac{7 \times N}{v \times t}$$

For example, if the diameter of the grain is .02 mm., v = 0.16 feet per second. If N pollens are gathered in twenty-four hours:

$$n = \frac{7 \times N}{.16 \times 24} = 1.8\,N'$$

If N' represents the number of pollen grains gathered per square centimeter on an atmospheric-pollen plate in twenty-four hours, and the number of pollen per cubic yard is represented by n, the following are the numbers by which N' is to be multiplied to give n for the pollen of different diameters:

Diameters	=	10 microns,	n	=	7.30 N'
"	=	15 "	n	=	3.20 N'
"	=	20 "	n	=	1.80 N'
"	=	25 "	n	=	1.20 N'
"	=	30 "	n	=	.80 N'
"	=	40 "	n	=	.45 N'
"	=	50 "	n	=	.30 N'
"	=	60 "	n	=	.20 N'
"	=	70 "	n	=	.15 N'
"	=	80 "	n	=	.12 N'

[1] Scheppegrell: Hayfever and Hayfever Pollens, Arch. Int. Med., June, 1917.

To obtain the number of pollens per kiloliter, divide the number N' per cubic yard by 1.3.

On October 10, 1920, the pollenometric records indicated nineteen common ragweed pollens for twenty-four hours. As this pollen has a diameter of 15 microns we multiply the number of pollens by 3.2 of the formula, which shows that there were sixty-one pollens in each square yard of air on that date.

NASAL FUNCTION IN ARRESTING HAYFEVER POLLENS.

A series of clinical tests were made in order to determine what percentage of atmospheric-pollens are arrested in the nostrils. The conformation of the nasal passages are especially adapted not only for warming and moistening the inspired air, but also for filtering mechanical impurities, the tests showing that over 70 per cent of the inhaled hayfever pollens were arrested in the nasal passages. The following is a record of one of these cases:

On August 12, 1916, all the nasal secretion of a hayfever patient for eight hours was collected. As the patient slept in an open sleeping-porch, the inhaled air contained the average number of aërial hayfever pollens of that date and location. The number of pollens which the secretion contained were then counted and found to be fifty-six. On the same date the pollenometric record showed ten giant ragweed (*Ambrosia trifida*) pollen for twenty-four hours. As these pollens have a diameter of 20 microns, the number of pollens per cubic yard were found to be ten according to our table of atmospheric-pollens. As the volume of air (tidal) for eight hours' respiration was 4.28 cubic yards, the patient had inhaled (4.28 $\times$ 18) seventy-seven pollens during the eight hours. As fifty-six pollens were found in the secretion, it demonstrated that the nostrils had arrested about 73 per cent of the pollen which the patient had inhaled.

THE POLLENS OF HAYFEVER VERIFIED BY THE ATMOSPHERIC-POLLEN PLATES.

The pollens responsible for hayfever are verified by the atmospheric-pollen plates, which are constantly exposed by our research department. During the prevalence of the spring hayfever, these plates, which are placed at various stations and also at the residence of hayfever patients, register the grass pollens principally, with a small percentage from other wind-pollinated plants such as the dock, amaranths and chenopods. In some localities the tree pollens are also registered. The number of pollens deposited bear a definite relation to the intensity of the hayfever attacks.

In the fall hayfever season (eastern and southern states), the pollenometric records show the presence of the ragweed pollens in large numbers. On August 15, for instance, the grasses have practically completed their pollination in most sections, and their pollens have almost disappeared from the air as shown by these plates. The patients who are affected with the grass pollens cease to suffer from hayfever, except in cases which are sensitive to both the grass and ragweed pollens. The ragweed pollens now show on the plates, and persons sensitive to their protein begin to develop their hayfever attacks.

BUOYANCY OF THE RAGWEED POLLENS.

Our pollenometric records demonstrate the remarkable buoyancy of the common ragweed pollen. In the vicinity of New Orleans the common ragweed (*Ambrosia elatior*) is not found, being replaced by the giant ragweed (*Ambrosia trifida*), the nearest being about five miles from the station from which the important pollen records were made. Nevertheless, during the prevalence of a twenty-mile wind, the common ragweed pollens were freely deposited on the plates located on the eighth floor of the Audubon office building, of New Orleans.

On the other hand, the atmospheric-pollen plates at our Hendersonville, North Carolina station (altitude, 2350 feet),

on September 22, 1920, after the pollination of the common ragweed had been ended in that section by the cold weather, gave negative results and hayfever entirely disappeared, although at a distance of fifteen miles the ragweeds were still pollinating profusely, and with the usual number of hayfever cases. While it has not yet been established to what distance the pollen of the common ragweed can be carried in sufficient numbers to cause hayfever, our records for the past ten years have shown that it will not traverse this distance.

Our New Orleans records have demonstrated that the common ragweed, under favorable wind conditions, will traverse a distance of five miles in sufficient numbers to cause hayfever. Our Hendersonville tests, however, have shown that a distance of fifteen miles is absolute protection against infestation by the hayfever pollens.

CHAPTER XIII.

POTENTIAL AREA OF HAYFEVER POLLENS.

As already stated, only the plants with wind-borne pollen need be considered etiologically in hayfever, and of these, only those which have been shown to give the hayfever reaction. The distance, however, to which these pollens are responsible for hayfever is influenced by their buoyancy, which therefore controls the potential area of these pollens.

The buoyancy of pollen varies principally according to their size, this being also influenced by their external shape. The size of the hayfever pollens varies within considerable limits, among the smallest being the common ragweed (Fig. 32), measuring 15 microns in diameter, and among the largest the pollen of the corn (80 microns) (Fig. 95).

As the potential area of wind-borne pollens is important in the consideration of hayfever, we have prepared a table by which this area for pollens of 10 to 100 microns in diameter, and with winds from 2 to 30 miles per hour, may be calculated.

CONVECTION OF HAYFEVER POLLENS.[1]

Any small particles which will appear to float in the air like a cloud of dust, fog, pollen, etc., are really going through a process of falling with a uniform velocity. The rate of falling is under these conditions independent of the density of the particle. If the surface of the particle is rough, the velocity is less than if it is smooth.

If the particles have the form of smooth spheres of a diameter not less than 0.001 mm., it has been shown both from

[1] Scheppegrell: Hayfever and Hayfever Pollens, Arch. Int. Med., June, 1917.

theory and by actual experiment that the velocity with such spheres fall, is given by formula:

$$v = \frac{2\,g\,r^2}{9k} \quad \text{(Stokes's law.)}$$

where v equals the velocity in centimeters per second, g equals 980 cm., the acceleration of gravity; r equals the radius of the sphere and k equals the coefficient of viscosity for air equals .00018.

By substituting the different values for the radius of spheres and the known constants in the above formula, the velocity of pollen grain of any size can be calculated. The calculation gives exact values for the smooth pollen grains only. The values will be considerably higher in the case of the pollen with spicules, the velocity being considerably less than the calculated value.

When the velocity has been calculated, the time of fall of a pollen grain can be calculated for any distance by dividing the distance by the velocity. If a wind is carrying the pollen horizontally while it is thus falling, the distance it will be carried is equal to the product of the velocity of the wind multiplied by the time of fall. In this way the distance which grains of different size will be carried, can be calculated.

The above formula has been used extensively in physical investigations and there are numerous proofs of its correctness. The accepted value of the electric charge of an electron or cathode particle depends on the accuracy of this formula.

The following is a table of the distances that pollen grains of various diameters will be carried by different winds from plants of different heights.

While this table is correct for distances on level ground and under a steady wind of the given velocity, these exact conditions are not often met with. Such obstructions as houses, trees and shrubbery will deflect the wind and cause the currents of air to go upward instead of horizontally. Hilly land also causes considerable variation in the effects of the wind, and also the vertical currents in summer. In

POTENTIAL RADII OF HAYFEVER PLANTS. (DISTANCE TRAVERSED BY POLLENS OF VARIOUS SIZES).

Diameter in microns.	Velocity of fall, ft., sec.	Distances in feet traversed by pollen blown from plant $2\frac{1}{2}$ feet high along level ground with wind velocity of:							Distances in feet traversed by pollen blown from plant 5 feet high along level ground with wind velocity of:						
		2 mi. per hr.	5 mi. per hr.	10 mi. per hr.	15 mi. per hr.	20 mi. per hr.	25 mi. per hr.	30 mi. per hr.	2 mi. per hr.	5 mi. per hr.	10 mi. per hr.	15 mi. per hr.	20 mi. per hr.	25 mi. per hr.	30 mi. per hr.
								$\frac{1}{2}$ mi.							1 mi.
10	0.04	184.0	460.0	920	1380.0	1840	2300.0	2760	368	920	1840	2760	3680	4600	5520
											$\frac{1}{6}$ mi.		$\frac{1}{3}$ mi.		.45 mi.
15	0.09	82.0	205.0	410	615.0	820	1025.0	1230	164	410	820	1230	1620	2030	2460
20	0.16	46.0	115.0	230	335.0	460	575.0	690	92	230	460	690	920	1150	1280
30	0.36	20.0	51.0	102	153.0	204	255.0	306	40	102	204	306	408	510	602
40	0.64	11.0	28.5	57	85.5	114	142.5	171	22	57	114	171	228	285	342
50	1.00	7.5	18.5	37	55.5	74	92.5	111	15	37	74	111	148	185	222
60	1.44	5.0	12.5	25	37.5	51	62.5	76	10	25	50	75	102	127	152
70	1.96	4.0	10.0	19	29.0	38	50.0	58	8	19	38	57	77	96	116
80	2.56	3.0	7.0	14	21.0	28	35.0	43	6	14	28	42	56	70	86
90	3.24	2.0	5.5	11	16.5	22	27.5	33	4	11	22	33	44	55	66
100	4.00	2.0	5.0	9	14.0	18	25.0	27	4	9	18	27	36	45	54

NOTE.—For spiculated pollens, add 10 to 50 per cent, according to their size and the length of the spicules.

spite of this, however, we have found this table of practical value as corroborated by our pollenometric records.

The common ragweed (*Ambrosia elatior*), for instance, measuring 15 microns in diameter and spiculated, will traverse ½ mile in a wind of 20 miles per hour on level ground, and many times this distance when deflected by upward currents, while the smooth corn pollen will travel only 102 feet under the same conditions. Under similar conditions, the pollen of the grasses (*Gramineæ*), which usually measures about 40 microns in diameter, will traverse 456 feet.

These calculations compare favorably with the records of our pollenometric records. The common ragweed (measuring 15 microns in diameter) will travel the greatest distance, which easily gives it the preponderance of hayfever cases in the localities in which it is found.

The insignificant number of cases of corn-pollen hayfever, compared with that of grass pollen for hayfever, is explained principally by the difference of size, causing a contracted radius of corn infestation. In addition to this, corn is not found as a weed in the cities and suburbs as we find the grasses and ragweeds, which together with the limited carrying distance, explains the comparative rarity of corn-pollen hayfever.

NUMERICAL DISTRIBUTION OF HAYFEVER POLLENS.

In addition to the convection of pollen by the wind, we must consider the numerical distribution of these pollens. This is not subject to any special rule as for the distance, and we must be guided by the pollenometric records as a basis of calculation.

These records show that this distribution is approximately inversely as the square of the distance. Theoretically, if the ground were level and the wind steady and from one direction, the distribution of the pollen would be inversely as the distance. On land, with its shrubbery, trees and buildings, the wind becomes a succession of wind currents, so that at one time the wind is at its full velocity, and at another may be almost still. During this interval the pollens

fall with a velocity shown in the table, and in this way a large portion is deposited on its way to the terminal distance based on the wind velocity. There are certain variations in the directions of the winds also, causing the pollen to be distributed in various directions. While, therefore, there is no exact rule for calculating the numerical distribution of the pollen, the rate established by our pollenometric records is approximately correct.

Some investigators have endeavored to calculate the amount of pollen generated by the ragweeds, and have estimated from this the amount of pollen in the atmosphere. As a matter of careful personal observation, however, over 50 per cent of the pollen usually falls within the immediate neighborhood of these weeds. This is shown by the fact that where they grow in great abundance the ground under them is colored yellow by the fallen pollen, this color rapidly diminishing a few yards from the plants. While, therefore, these pollens are distributed in great numbers, the quantity in the air is really only a small proportion of the pollen generated.

The buoyancy of the common ragweed pollen can be better appreciated when it is stated that it requires 380,000,000 pollen grains to 1 gram.

AMOUNT OF POLLEN GENERATED BY HAYFEVER PLANTS.

In order to ascertain the number of pollens generated by hayfever weeds, the following test was made on June 24, 1916:

Six of the flowers of the bastard feverfew (*Parthenium hysterophorus*), while attached to the parent plant, were enclosed in a small case, one end being left open to prevent the accumulation of moisture. At the end of four days the floor of the receptacle was found to be dusted with the pollen. To facilitate the counting, this area was divided into 110 squares and the pollen of one of the squares placed under the microscope. This gave a count of approximately 5000 pollens for each square. As there were 110 squares, this

showed that there were 550,000 pollens in the receptacle. Dividing this by 4 gave the number of pollens distributed by one flower in one day, this being 22,916 pollens.

An average large bush (3 feet, 10 inches in height) of the bastard feverfew was then selected and the flowers counted, this being done by cutting off each flower. This count gave 9902 flowers to the bush. Multipling this by the number of pollens distributed by each flower, showed that the parthenium generates approximately 227,000,000 pollens per day.

The ragweeds, however, are much more prolific in their pollens as shown in the following test: On August 23, 1916, a plant of the giant ragweed (*Ambrosia trifida*) was placed in such a position in the biological laboratory that all the pollen fell on the platform on which the plant was placed. The pollen which fell from 8 A.M. to 1 P.M. was divided into spaces and the pollen of one of these placed under the microscope and counted. The total number calculated from these was found to be approximately 8,000,000,000 pollens.

Similar experiments demonstrated that the number of pollens generated in a field of grasses (*Paspalum dilatum*) during the active stage of pollination was about 8,000,000 per square foot of surface. On account of the short distance from the ground (18 inches) and the large size of the pollen (40 microns) only a small proportion of this is carried into the air except during winds of high velocities (15 or more miles per hour).

An interesting point in connection with atmospheric-pollen was demonstrated by these plates. A number of published reports show that atmospheric-pollen came from the direction of the sea in which the nearest land was two hundred miles, and it was, therefore, concluded that the pollen had traversed this great distance.

In New Orleans the ragweed area is northeast to northwest of the city, and under ordinary circumstances comes from this direction. On September 29, 1916, when the pollination of the ragweed was at its height in this locality, the wind, which was from the northeast, rose to 22 miles per hour, and the pollen count reached 114 per square centimeter. Two days afterward, the wind veered to the southeast, in

which direction but little ragweed is found. The pollen plates, however, continued to show 19 pollens per square centimeter for two days afterward. This indicates that the high wind had infested the atmosphere with the ragweed pollen for so many miles and to such an altitude, that for several days it continued to descend from the direction in which it had been carried. Had the initial record of the northeast wind not been made, it would have been supposed that the pollen had originated from some southern point of great distance.

CHAPTER XIV.

ATMOSPHERIC CONDITIONS IN RELATION TO HAYFEVER.

THE EFFECT OF WIND.

MOST hayfever subjects are aware of the fact that their symptoms become aggravated during the prevalence of high winds. This is due to the fact that during high winds, not only are more pollens shaken from the plants, but the liberated pollens are carried to proportionately greater distances.

Our pollenometric records have demonstrated that there is a definite relation between the wind velocities and the amount of pollen in the air, the clinical reports proving that there is a similar relation between the atmospheric-pollen and the symptoms of hayfever subjects.

The following table, which is a partial report of one of our stations, shows the records of the atmospheric-pollen plates in relation to the daily maximum and mean wind velocities and directions, the estimated number of pollens per cubic yard of air, the mean temperatures and the rainfall. As this station is at an elevation of 100 feet (eighth floor of office building) and at least two miles from any large weed areas, the records are uninfluenced by any special local conditions. The table gives the number of grass pollens, of *Ambrosia* pollens (common and giant ragweed) and of "other pollen," the latter including the docks, amaranths, chenopods, marsh elders and cockle burs, all of which give a positive reaction for hayfever, but are in this locality of minor importance.

Our clinical records show that the most severe symptoms of fall hayfever were on September 29, 30, 31 and October 1, and these corresponded with the high wave of the recorded pollen count.

HAYFEVER POLLENS IN RELATION TO WIND, TEMPERATURE AND RAIN.

	Grass pollens	Ambrosia pollens	Other pollens	Number of pollens per square yard of air	Maximum wind	Mean wind	Direction	Mean temperature	Rain
1916.									
Sept. 22	4	5	2	29	10	3.8	N.W. S.	78	0.0
25	..	7	..	22	14	5.4	S. S.E.	80	0.0
26	1	9	..	31	16	6.0	S. S.E.	80	0.01
28	..	15	..	48	15	4.3	S. N.E.	82	0.02
29	..	114	..	365	22	13.4	N.E.	68	0.0
Oct. 1	..	36	..	115	16	7.5	N.E. E.	68	0.0
2	..	10	..	61	14	7.4	S.E. E.	71	0.0
3	..	6	..	19	12	5.9	E.	72	0.0
4	..	7	..	22	12	6.2	N.E. E.	74	0.0
5	..	11	..	35	21	10.7	N.E.	73	0.01
6	2	6	2	29	16	7.2	N.E. E.	78	0.01
7	1	7	..	26	17	7.9	E. N.E.	76	0.02
8	..	2	..	6	12	4.3	N. S.E.	80	1.85
9	..	8	..	26	7	2.9	N.W. S.	80	0.0
10	..	12	1	42	18	9.6	N.E.	74	0.0
11	..	11	..	35	18	7.7	N.E.	73	0.0
13	..	3	1	13	7	4.3	E. S.E.	77	0.0
14	..	9	2	35	10	5.0	S.E. S.	78	0.0
17	..	..	..	0	25	14.0	E.	72	2.58
18	..	1	4	16	24	11.5	N.E. S.W.	74	0.19
19	..	23	5	90	15	7.9	N.E. S.W.	76	0.0
20	..	5	5	32	23	13.4	N.W.	62	0.0
21	..	12	2	45	15	8.5	N.W.	58	0.0
24	..	..	2	6	8	4.2	E.	67	0.0
25	..	1	1	6	15	7.1	N.W.	70	0.0
26	..	8	2	32	17	10.1	N.E.	62	0.0
27	..	1	3	13	15	8.5	N.E.	66	0.0
28	..	1	8	29	12	6.5	N.E. E.	67	0.0
29	..	..	1	3	9	4.5	N.W. N.	70	0.0
31	..	..	2	6	8	3.7	N.W.	72	0.0

After the patients have become sensitized by a large number of pollens, they react to a smaller number than under former conditions. Thus, each period of aggravated hayfever was followed by symptoms in excess of the record of the pollen counts.

As will be noted, these counts are influenced not only by the wind velocity, but also by its direction, and the locality of the nearest large weed areas. On September 22, there were 11 pollens per square centimeter with a wind of 10 miles from the northeast, while on September 25 there were only 7 with a wind of 14 miles from the southeast.

Toward the latter part of October the pollination of the ragweed was reaching its limit, which explains the irregular count after October 15. On October 28 the ragweed pollens were no longer recorded on our plates, and our clinical records show that the fall hayfever season had passed.

The effect of rain on the pollen was also clearly indicated. On October 17 the rain of 2.58 inches caused the ragweed pollen to disappear from the plates during that day, showing the air to be free of pollens, and this was also the case the following day (1 per square centimeter) in spite of the fact that the wind had reached a velocity of 24 miles per hour and was from a northerly direction. Local showers have little effect as shown on September 26 and 28 and October 5, 6 and 7.

INFLUENCE OF TEMPERATURE.

It has been frequently reported that hayfever is aggravated by hot weather, but our records prove that high temperature has no direct effect. On the contrary, the records, both pollenometric and clinical, show that many of the severe stages of hayfever develop on days when the temperature is unusually low for the season. Thus, the most severe stage of hayfever during the 1916 season in New Orleans was on September 29 and 30, when the mean temperature was 78°. The lower temperature, however, was only incidental, being due to the high wind (22 miles per

hour) which blew from the northeast, which in this case is also from the direction of the hayfever-weed area.

EFFECTS OF RAIN.

It is well known that a continued rain affords relief to hayfever patients. The action of the rain is to precipitate the pollen floating in the air, and to prevent more pollen from rising from the plant during its continuance. If the rain is sufficiently prolonged to allow the effects of inhaled pollen to pass off, the patient has relief until the rain is over, and a wind of sufficient velocity again infests the air with the hayfever pollens.

It has been supposed that the pollens, which are precipitated by the rain, may again be carried into the air and continue their irritating effect. This, however, is not the case. The principal varieties of pollen have been tested in our biological laboratory, and it has been found that the submersion of the pollen in a large amount of water removes their irritating properties. After the pollens have been exposed in this way, they have been tested in large numbers without effect in the nostrils of hayfever subjects who ordinarily react to a small number of fresh pollens.

The result of this investigation is of practical value in certain cases of hayfever. When a hayfever subject has been operated upon or is seriously ill from other causes so that the irritation of sneezing and other symptoms of hayfever would not only be annoying but even dangerous, the patient may be protected by having the windows of his room screened with a thin cloth saturated with water. All pollens coming in contact with the moist cloth would not only be arrested but be robbed of their toxicity.

When this is not practical a special inhaling mask, based on the same principle, may also be arranged for the patient for this purpose.

HAYFEVER AND DUST.

It is well known that persons suffering from hayfever have their symptoms aggravated by the dust of a carriage

or automobile drive, and this was therefore made the subject of a series of tests. The atmospheric-pollen plates exposed on these trips not only showed pollens mixed with the dust, but also that these were present in large proportions. A photomicrograph of a portion of one of these plates is shown in Fig. 97.

We also exposed a series of these plates on railroad trips during the hayfever season. When the cars passed through localities where hayfever weeds were found in abundance,

FIG. 97.—Atmospheric-pollen plate, showing pollen in dust. (× 250.)

the records showed a large increase over the pollens ordinarily found in the air, this being sometimes over 100 per cent. In passing through large forests, away from cultivated lands and over water and marshes, as in certain portions of the coast of Louisiana, the number of pollens was greatly reduced.

The following case illustrates the borderline between ordinary hyperesthetic rhinitis and true hayfever. The patient, a man aged thirty-two years, has his office in New Orleans, but resides in the country, about forty miles from

the city. Ordinarily he makes these trips without discomfort. He also visits in the country while the ragweeds are pollinating, without developing hayfever. During the hayfever season, however, he suffers from severe attacks while travelling on the train. In other words, the dust and cinders of the trip are ordinarily not sufficiently irritating to annoy him, and the pollens of the ragweed, also under ordinary conditions do not cause hayfever, but the combined effects of the dust of the train and the atmospheric pollens

FIG. 98.—Atmospheric-pollen plate exposed on railroad trip. (× 250.)

invariably cause an attack of hayfever. As soon as the pollen disappears from the air, he again travels without discomfort.

An atmospheric-pollen plate was given him to expose during the trip, a photomicrograph of a section of the result being shown in Fig. 98. The record showed a high percentage of pollen.

During the hayfever season, even the dust of the houses is impregnated with the hayfever pollens. The series of atmospheric-pollen plates exposed at various times show

that the air of the ordinary house has an infestation of hayfever pollens varying but little from the air out of doors.

The action of electric fans tends to disturb this dust and the contained pollen, which is one of the reasons that hayfever patients object to the use of electric fans during their hayfever attacks. This also explains the distress experienced by hayfever subjects in theatres and other buildings, where typhoon fans are used for ventilation.

CHAPTER XV.

POLLEN IN THE NASAL SECRETION OF HAYFEVER CASES.

THE direct relationship of the pollen of certain plants to hayfever has been established in many ways. First, the commencement and disappearance of the attack with the beginning and ending of the blooming of these plants. Also the development of the attack when susceptible subjects come within the potential area of the hayfever plants. Then the confirmation of the biological test, by means of which an attack may be induced at any season of the year by applying a few grains of pollen to the nostrils of the hayfever subject.

While these have fully established this relationship, the finding of the pollens in the nasal secretions of hayfever patients is an important corroboration. The following report of our biological department is of interest not only for this, but also as indicating the total number of pollens in connection with an attack of hayfever:

On August 12, 1916, F. W., who suffers from fall hayfever, had an attack during the night, this being due to a brisk northwest wind which blew pollen from a large area of ragweed about one-half mile distant. Shortly after retiring, his nostrils became obstructed so that he could continue nasal breathing only by propping up his pillows, and then only through one nostril.

The following morning, when the patient arose and exercised, the nostrils became free, which was followed by the discharge of a clear, viscid mucus from the nostrils. By previous agreement, this mucus was collected and sent to our biological laboratory for testing. After the discharge of this mucus, which lasted about ten minutes, the patient

was practically relieved from any further discomfort, as he left for his office which is in the central portion of the city, and farther removed from the potential area of the ragweed pollens.

The mucus was divided into eight parts, each being separately examined. The secretion was spread on microscope slides, and covered with ordinary glass covers, and a drop of Lugol's solution injected for staining. The microscopic examination showed that there was an average of seven ragweed pollens (*Ambrosia trifida*) to each division, or a total of fifty-six pollens in the secretion collected.

The following points are to be noted in this investigation: The direct relation of the pollen to the attack, and the number required to cause the reaction described.

Ragweed pollen is frequently found in the nasal secretion of hayfever subjects at our biological laboratory, but this is the first instance in which practically all the pollen of an attack of hayfever has been collected and examined.

CHAPTER XVI.

TESTING THE WIND-POLLINATION OF HAYFEVER PLANTS.

THE only pollens which may cause hayfever are those which are found in the air, and which are distributed by plants which are wind-pollinated. In many plants, the pollen has easy access to the pistil or fertile parts of the flower, while in others this transfer is made by means of insects. In wind-pollinated plants, however, the pistillate and staminate flowers are at a distance from one another, and, in some cases, are on separate plants or trees, so that fertilization is dependent upon the wind which carries the pollen, sometimes for considerable distances.

On account of the great loss incident to this method, the pollens of wind-pollinated plants are generated in enormous quantities; in fact, there are usually millions of pollens lost to one that is actually used for fertilization. This is exemplified in the oak, pine, willow and other trees; in the ragweeds, marsh elders, cockle bur and other plants with spiculated pollen; and in the grasses, amaranths and yellow dock, with smooth pollen.

There are many plants, however, whose pollen gives a positive reaction of hayfever when inhaled directly from the flower, but which do not otherwise cause hayfever, as their pollen is not found in the air. This is the case with the golden rods, daisies, dandelions, sunflowers, etc.

As it is important, therefore, to determine which plants are wind-pollinated, an apparatus called the anemophilometer[1] has been devised in the biological laboratory of the American Hayfever Prevention Association, by means of which this test may be made without the necessity of visiting the growing plant.

[1] The anemophilometer is so-called as it is used for testing anemophilous (wind-pollinated; literally "wind-loving") plants.

The apparatus (Fig. 99) consists of a hollow cylinder with a fan attached at one end, which is operated by a set of pulleys by means of which the current of air may be given any velocity from 1 to 15 miles per hour. The flowers to be tested are held in place by means of an attachment in the center of the tube, at the outer end of which there is a receptacle, at an angle of 45 degrees, for holding the glass slides on which the pollen is deposited.

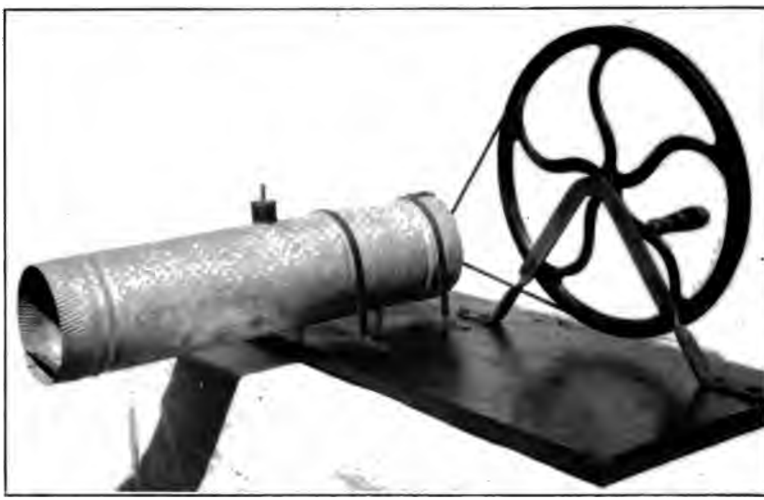

FIG. 99.—Anemophilometer for testing the wind-pollination of plants.

The slide is given a thin coat of glycerin, as in the case of the atmospheric-pollen plates, so that the pollens which come in contact with it are collected. The wind velocity is noted, and the length of time, so that a quantitative count of the pollens may be made.

When the slide is removed a glass cover is placed over the glycerin, and a stain of Lugol's solution is added to facilitate the count. This is made with a mechanical stage by means of which every part of the glass slide is passed across the field of the microscope. The count is then calculated per square centimeter of the exposed glycerin. A photo-

micrograph of a small portion of a slide is shown in Fig. 100, which has collected the pollen of the ragweed.

The hayfever pollens which have given the highest average in these tests are those of the common ragweed (*Ambrosia elatior*), which is closely followed by the giant ragweed (*Ambrosia trifida*) and the marsh elder (*Iva ciliata*). The grasses (*Gramineæ*) also, which are the principal cause of spring hayfever, distribute their pollen in enormous quantities, but their potential area is more restricted on account of the greater size of these pollens (average diameter 40

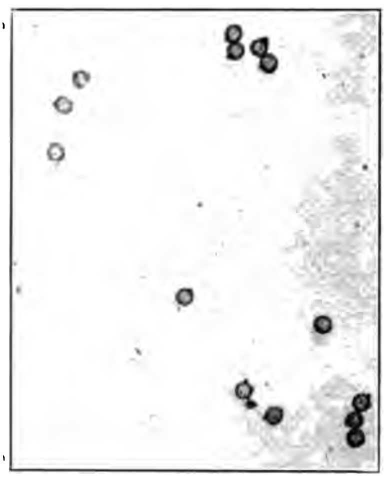

FIG. 100.—Test-slide of anemophilometer, with giant ragweed pollen. (× 125.)

microns). This is especially the case with the pollen of the corn. This pollen gives a positive hayfever reaction similar to the grass pollens, but its size (80 microns in diameter) limits its potential area. Under the same wind conditions that the common ragweed pollen (15 microns in diameter) would traverse one-half mile, the corn pollen would traverse only 43 feet. On this account, hayfever from corn is rare, as a patient sensitive to its pollen, must be in the cornfield or within a short distance of it, during its pollinating season, in order to be affected.

CHAPTER XVII.

THE SPECIAL POLLENS OF HAYFEVER.

THE knowledge of the exact pollens which cause hayfever is important from an etiologic as well as from a prophylactic and therapeutic standpoint. In the prevention of hayfever, we must know the plants which produce the noxious pollens in order to eradicate them, or prevent them from reaching their pollinating stage, and, where these measures are not feasible, to have the patient avoid localities infested with these pollens. This knowledge is equally necessary from a therapeutic standpoint, as the modern treatment of hayfever is based on pollen therapy, the correct application of which requires the knowledge of the proper hayfever pollens.

Hayfever pollens are not deleterious to health *per se*, as the great majority of persons (99 per cent) are not inconvenienced by them. Those suffering from hayfever have a special sensitivity to these pollens, the aim of modern methods being to correct this by immunizing the patient against these pollens.

The usual method of testing the susceptibility of the patient by applying an extract of various pollens to the conjunctival sac or scarified skin, does not always give reliable results, as the question is not whether a patient reacts to various pollens, but whether he is sensitive to the pollen to which he is exposed.

We have, for instance, persons in the east susceptible to the pollen of the western mugwort (*Artemisia heterophylla*), but the therapeutic use of this extract, in spite of the patient's reaction, would not be indicated in New York or Pennsylvania, as this plant is found in the Pacific states and not in the eastern or southern states. In the same manner, patients in California may react to the pollen of the common ragweed (*Ambrosia elatior*), but the use of this extract would not be

advisable in California as the common ragweed is rare in that state.

The correct test of the patient's susceptibility, therefore, should be directed to the pollen to which he is exposed. This may easily be determined by the atmospheric-pollen plates, and the information obtained from these should form the basis of applied pollen therapy.

THE COLLECTION AND IDENTIFICATION OF ATMOSPHERIC-POLLENS.

The atmospheric-pollen plates are ordinary glass slides used for the microscope, the central square inch being covered with a uniform coating of glycerin. In localities in which the humidity causes too great liquefaction of the glycerin, we use a thin coating of boiled linseed oil.

When these plates are examined we apply an ordinary thin glass cover, and place the slide on a mechanical stage so that the whole field may be traversed. As the glycerin usually leaves a surface of uneven refraction, it is necessary to inject a solution that will correct this. We use the ordinary Lugol's solution of iodine and iodide of potash, which not only corrects the refraction but simplifies the identification of the pollens.

All the grass (*Gramineæ*) pollens, on account of the high percentage of starch, are stained blue-black, which easily distinguishes them from all other pollens (Fig. 12). The members of the *Ambrosiaceæ* group, including ragweeds, marsh elders, gærtnerias and cockle burs, are stained brown by the iodine and are recognized by the spicules (Fig. 4). The amaranths (*Amaranthus*), chenopods (*Chenopodium*), docks (*Rumex*) and other members of the *Chenopodiaceæ* group, have a low percentage of starch, and are partially stained by the iodine. These pollens are spherical and smooth (Fig. 43).

The wormwoods (*Artemisias*) are stained brown and are recognized by their three-lobed appearance when seen from the end, otherwise they appear ovoid with one of the lines of the lobes showing longitudinally (Fig. 10).

In our biological laboratory, where we have the photomicrographs of over four hundred varieties of pollens, their identification is not difficult. Ordinarily, however, the number of varieties of atmospheric-pollen appearing on the plates is not great, and it soon becomes easy to identify them.

While several varieties of pollen are usually found, the chief pollen is distinguished by its greater numbers. The occasional appearance of a new pollen on the plates is not of any biological importance.

FIG. 101.—Atmospheric-pollen plate, showing pollen of mountain cedar (*Sabina sabinoides*). (× 500.)

After the pollens have been identified and counted, they are estimated on the basis of the number per square centimeter for twenty-four hours. This number, which has a definite relation to the number of pollens per cubic yard or kiloliter of air, is important in its bearing on the development of hayfever and its severity. With most pollens, 25 per square centimeter indicates that there is sufficient pollen in the air to cause hayfever in most subjects, and 100 that the number of pollens will cause attacks of con-

siderable severity. In the case of the wormwoods (*Artemisias*), a much smaller number is sufficient to produce this effect.

The use of the atmospheric-pollen plates is important in the practice of pollen therapy. Its value was demonstrated in determining the cause of an outbreak of hayfever in Austin, Texas. Our atmospheric-pollen plates were exposed by Dr. S. N. Key, and sent to our biological laboratory. The examination of these (Fig. 101) showed that the air contained an average per kilometer of 88 pollens of the mountain cedar (*Juniperus sabinoides*), the biological test of which showed a marked hayfever reaction. As the cedar has not heretofore, to our knowledge, been identified with hayfever, the importance of the atmospheric-pollen plates in such cases was clearly demonstrated.

CHAPTER XVIII.

THE CLASSIFICATION OF HAYFEVER PLANTS.

WHILE the prevention of hayfever by the eradication of the hayfever weeds is of the highest importance, it will evidently be many years before this becomes sufficiently general to eliminate the question of treatment. While most cases of hayfever, moreover, are due to the pollen of noxious weeds, there is also a certain number of cases due to plants and trees of economic value, as for instance rye and other grains, black walnut, mountain cedar, etc. In view of this, the treatment will probably continue to be an important consideration in hayfever.

Among the various treatments which have been tried, pollen therapy has, thus far, given the most encouraging results. The variety of plants, however, which may cause hayfever is exceedingly large. Of the wormwoods (*Artemisias*), the most important hayfever plant of the Pacific and Rocky Mountain states, there are about two hundred varieties. There are about fifteen varieties of ragweed (*Ambrosias*), and as many of the marsh elders (*Ivas*) and cockle burs (*Xanthiums*), while of the grasses (*Gramineæ*), there are several thousand varieties.

If the application of pollen therapy required the use of the extract of the same pollen to which the patient is sensitive, it would clearly make this method impracticable, especially as most patients react to many different pollens.

We have conducted a careful series of investigations with a view of segregating all the most common hayfever pollens into groups which should be morphologically alike, and the number of which should be as few as possible in order to simplify the question of pollen therapy. Thus far, we have succeeded in reducing the number to four groups. Should

we succeed in finding a pollen which would morphologically represent these four groups, it would still further simplify the application of pollen therapy.

The four groups into which we have divided the principal hayfever pollens are the following: *Ambrosiaceæ*, *Artemisia*, *Chenopodiaceæ* and *Gramineæ*.

THE AMBROSIACEÆ (RAGWEED) GROUP.

An extended series of tests at our biological laboratory has shown that all the pollens of the *Ambrosiaceæ* family have a marked resemblance both microscopically and in their hayfever reaction. All the pollens are spiculated and vary only in size, and they present a similar reaction to the Lugol solution. While their hayfever reactions vary somewhat in the different genera, their similarity in this is quite sufficient to enable us to segregate them into a single group.

Principal among the *Ambrosiaceæ* is the common ragweed (*Ambrosia elatior*), which is responsible for 85 per cent of fall hayfever in the eastern and southern states. Its pollen (Fig. 4) is spiculated and measures 15 microns in diameter. The giant ragweed (*Ambrosia trifida*), which replaces the common ragweed in moist sections, and which, in the general appearance of the plant has not the slightest resemblance to the common ragweed, has a pollen (Fig. 34) with the same hayfever reaction and microscopically differing only in size (20 microns). The western ragweed (*Ambrosia psilostachya*) also has a similar hayfever reaction, and the pollen (Fig. 37) is similar except in its size (25 microns).

The *Gærtneria*, sometimes called "false ragweed," also belongs to the *Ambrosiaceæ* family. The pollen gives a hayfever reaction similar to the common ragweed and resembles them so much that they are difficult to distinguish microscopically.

The marsh elder (*Ivas*) is also a genus of the *Ambrosiaceæ* family and gives a reaction similar to the ragweeds but less marked. The extract requires 20 per cent more strength to produce a hayfever reaction similar to that of the ragweeds. The spicules also are less prominent but more numerous

(Fig. 41). They resemble the *Ambrosias* in the amount of pollen generated. The principal varieties in the eastern and southern states is the rough marsh elder (*Iva ciliata*), but this is not sufficiently common to be of great importance except in certain moist localities. In the Pacific and Rocky Mountain states, however, we have found the small-flowered marsh elder (*Iva axillaris*) and burweed marsh elder (*Iva xanthiifolia*) important factors in hayfever.

The cockle burs (*Xanthiums*) also belong to this family and resemble the other species in the microscopic appearance and biological reaction. The spicules, however, are even less prominent than in the *Ivas* and more numerous (Fig 14). The reaction is also less marked, being about 70 per cent of the strength of the ragweed reactions.

This resemblance in the *Ambrosiaceæ* family of their biological reaction is very important from a therapeutic standpoint. Our tests have shown that the large majority of persons susceptible to one member of the group is susceptible also to the others, so that all of the *Ambrosiaceæ* family can morphologically be classified into a single group. As these form the principal cause of fall hayfever in the eastern and southern states, the practical application of this greatly simplifies the subject of pollen therapy.

THE GRAMINEÆ (GRASS) GROUP.

In the *Gramineæ* (grass) family we have also a general similarity of reaction. As there are altogether nearly 5000 species of grasses, this is fortunate from the standpoint of pollen therapy. In practically all the cases which we have tested, subjects sensitive to grass pollens are also susceptible to other members of the group. The pollen of all the grasses are relatively large (30 to 50 microns), spherical and are stained blue-black by Lugol solution on account of the high percentage of starch which they contain.

The varieties of grasses vary greatly in different localities, but their reactions differ only in degree. This includes also the cereals, such as corn, rye, wheat and oats. The pollen of these, however, are relatively large (corn, 80 microns,

Fig. 95; wheat, 50 microns Fig. 102, and rye, 45 microns) so that they are not responsible for hayfever except within limited areas. The grasses with small pollen such as Bermuda grass (*Capriola dactylon*) and June grass (*Poa annua*) are potentially responsible for more cases than the grass with large pollen such as foxtail grass (*Chætochloa glauca*), paspalum grass (*Paspalum dilatum*), barnyard grass (*Panicum crus-galli*), etc., on account of their greater buoyancy which enables them to traverse a larger territory.

FIG. 102.—Pollen of wheat; cause of hayfever in some states. (× 500.)

THE ARTEMISIA (WORMWOOD) GROUP.

The wormwoods (*Artemisias*) also bear a marked resemblance to one another in their microscopic appearance,[1] and in their chemical and biological reactions. The three-lobed form is characteristic of all the *Artemisias* which we have examined as, for instance, the mugwort (*Artemisia heterophylla*), wormwood sage (*Artemisia frigida*), sagebrush (*Artemisia tridentata*), absinth wormwood (*Artemisia absinth-*

[1] The only exception is the *Artemisia biennis*, which has spiculated pollen but is otherwise similar in appearance and reaction.

ium), dark-leaved mugwort (*Artemisia ludoviciana*), biennial wormwood (*Artemisia biennis*), California old man (*Artemisia californica*), indian hair tonic (*Artemisia dracunculoides*) and bud brush (*Artemisia spinescens*). The wormwoods are the most important hayfever plants of the Pacific and Rocky Mountain states, and the hayfever reaction of all the varieties which we have tested is marked, being many times more active than that of the ragweeds.

THE CHENOPODIACEÆ (CHENOPOD) GROUP.

Among the plants which rank next to the *Ambrosiaceæ* and *Gramineæ* groups in their relation to hayfever, are the members of the amaranth, chenopod and dock families, which are both numerous in their varieties, and general in their geographical distribution, over fifty of each having been described, most of them being typical hayfever weeds and wind-pollinated.

The members of the amaranth (*Amaranthaceæ*), chenopod (*Chenopodiaceæ*) and dock (*Rumex*) generate pollens which are smooth and spherical (Fig. 43) and having a general resemblance to one another. They also have a similar reaction to the Lugol solution, indicating a low percentage of starch. All the varieties tested give a mild hayfever reaction and, with few exceptions, persons susceptible to one species react also to other members of the group.

The *Chenopodiaceæ* represents a large family, which includes in addition to the true chenopods, several other varieties such as the orache (*Atriplex*), the grease weeds (*Sarcobatus*) and Russian thistle (*Salsola*), the latter being an important factor in hayfever in some sections. They all give a similar hayfever reaction.

The branch of the *Amaranthaceæ* family, which has several members of interest in hayfever, are the *Acnidas* or water hemp. Some of these, as western water hemp (*Acnida tamarascina*) generate a large amount of pollen (Fig. 103). Most of these are limited to swamps and moist land. The reaction is similar to that of the amaranths, docks and

chenopods, which they also resemble in the general appearance of the pollen.

While most of the members of this group give a mild hayfever reaction, they are sometimes of importance by causing hayfever at seasons when the grasses, ragweeds and wormwoods are not pollinating.

FIG. 103.—Pollen of western water hemp (*Acnida tamarascina*); minor cause of hayfever in moist sections from Illinois to South Dakota. (× 500.)

The similarity of the amaranths, chenopodiums, water hemp and docks, both as regards the character of the hayfever reaction and the individual susceptibility to these pollens, demonstrate a similarity in their protein. The practical application, therefore, is that a pollen extract of any of these pollens will be applicable to all the members of this group.

POLLENS NOT INCLUDED IN THE PRINCIPAL GROUPS.

In addition to the members of these groups, there are local and exceptional cases of hayfever, due to pollens not

included in this classification. This is the case, for instance, with the western cottonwood (*Populus sargentii*), the mountain cedar (*Sabina sabinoida*), found in certain parts of Texas, and the black walnut (*Juglans nigra*). These pollens bear no resemblance in their appearance, chemical or biologic reaction, and must therefore be given individual consideration.

The four groups which we have described, however, include most of the pollens that are responsible for hayfever. As this investigation has been carefully conducted, we believe that it will not only simplify the subject of pollen therapy, but also place it on a more scientific basis.

CHAPTER XIX.

RELATION OF HAYFEVER TO THE MOST COMMON PLANTS, TREES AND GRASSES.

WHILE the etiological relation of pollens to hayfever is fairly well established, the special plants that are responsible are not well known, as indicated by the frequent inquiries on this subject. While the ragweeds (*Ambrosia elatior*), for instance, are accepted as the principal cause of hayfever, our correspondents inquire as to the toxicity of numerous harmless plants such as the honeysuckle, lily, rose, daisy, strawberry, golden rod, chrysanthemums, resin weed, aster, evening primrose, etc. As some of these are listed as hayfever plants, even in our standard text-books, we have prepared a list showing the result of our investigations as a practical guide on this subject.

As already stated, the characteristics of hayfever plants are as follows: (1) They are wind-pollinated; (2) very numerous; (3) the flowers (fluorescences) are inconspicuous, without bright color or scent; and (4) the pollen is formed in large quantities.

Ignorance of the fact that the plants, which cause hayfever, must necessarily be limited to those which are wind-pollinated, is responsible for much of the confusion on this subject. While the roses, for instance, are not wind-pollinated, being typical insect-pollinated plants, the term "rose cold" is still commonly used, even by physicians, for the vernal type of hayfever due to the pollen of the grasses.

While logical reasoning will show that only those pollens, which are inhaled in normal respiration, can cause hayfever, this has been corroborated by our atmospheric-pollen plates which are exposed daily at various stations.[1]

The procession of the pollens are carefully recorded from the pollination of the trees in early spring, followed by the grasses, and ending with the ragweeds in the fall, and neces-

[1] Scheppegrell: Hayfever and its Reactions, Arch. Int. Med., 1917.

sarily only the pollens of wind-pollinated plants are found on the plates.

While wind-pollinated plants alone are responsible for hayfever, we have tested many others which have been added to the list. Some of these will cause an acute attack of hayfever on direct inhalation, which occasionally happens, especially with children. In this class are included such plants as the daisy fleabane (*Erigeron strigosus*), golden rod (*Solidago canadensis*), aster (*Chrysopsis*), corn flower (*Centaurea*), sunflower (*Helianthus*), etc.

The *sizes of the pollens* are given in this list, as this has an important bearing on their potential area. That the common ragweed (*Ambrosia elatior*) is so widespread in its noxious effect, is due not only to its abundance, but also to its small size (15 microns). On this account, it is so buoyant that, when the wind reaches a velocity of 20 miles per hour, it will travel several miles, while, on the other hand, the pollen of the cockle bur, on account of its greater size (34 microns) will travel only one-quarter of this distance, and will therefore infect only one-sixteenth of the same area. The pollen of corn (80 microns) under the same conditions will traverse only one-thirtieth of the distance, and spread over only one-nine-hundredth of the area infected by the ragweed. On this account the corn pollen, although noxious to persons sensitive to the grass pollens, is rarely responsible for hayfever.

The *quantity of pollen* generated by the plants is also stated in this list. The terms are relative as compared with the number of pollen generated by the ragweeds. The number of pollens on the daisies and sunflowers, for instance, are many thousands, but our investigations have shown that a single ragweed plant (*Ambrosia elatior* or *trifida*) may generate millions of pollens daily,[1] so that the quantity of the former are listed as "small" and of the latter "abundant."

The amount of pollen generated by a plant is an important item in its potential responsibility for hayfever. In spite of the noxiousness and great buoyancy, the ragweeds would not be an important factor in hayfever, were it not

[1] The pollen of the common ragweed (*Ambrosia elatior*) measures 15 microns, and there are about 420,000,000 to the cubic centimeter.

for the enormous quantity which they distribute into the air. Our atmospheric-pollen plates (Louisiana stations) have shown that from September 22, 1916, to October 22, 1916, there were an average of 33 ragweed pollens per cubic yard of air, while on days of unusual atmospheric disturbances the number rose as high as 365.

The *periods of bloom* (florescence) of the various plants are given, as this will assist in establishing the differential diagnosis of hayfever. The common ragweed (*Ambrosia elatior*), for instance, in most locations blooms from August 15 to October. An attack of hayfever in June or July could therefore not be due to the ragweeds, but to some other plant blooming during these months.

The *geographical distribution* of the plants is also given as furnishing a certain amount of assistance. An attack of hayfever in Pennsylvania cannot be due to the mugweed (*Artemisia heterophylla*), as this plant, which we have found to be an important cause of hayfever in the Pacific and Rocky Mountain states, is not found in Pennsylvania. The same principle applies to other plants in this list.

Every plant listed has been carefully tested for the hayfever reaction. With some of the plants, such as the ragweeds, grasses, wormwoods and chenopodiums, hundreds of tests have been made in our biological laboratory and in making the differential diagnosis preliminary to immunizing patients against hayfever.

In the most important hayfever plants, such as the ragweeds and wormwoods, the most common species have been listed. With most of the plants and trees, however, only a few of each genus are given, as we have found it a rule that the species of a family, in spite of considerable variation in size and general appearance, have pollens which are similar in their hayfever reactions.

Many of the plants on this list have been sent to our biological laboratories for testing from all parts of the United States. The remainder have been collected in the course of regular surveys for hayfever plants by members of our research and botanical departments. The list, which represents the result of several years' investigation, has been of practical value in our hayfever work, and will prove, we hope, of assistance to the medical profession.

PLANTS TESTED FOR HAYFEVER REACTION AT THE BIOLOGICAL LABORATORY OF THE AMERICAN HAYFEVER PREVENTION ASSOCIATION.

Botanical names.	Principal common name.	Surface of pollen.	Size in microns.	H-F. reaction.	Pollination.	Amount of pollen.	Seasons of bloom.	Geographical distribution.	Remarks.
Acalypha caroliniana	Hornbeam	Smooth; ovoid	25 x 32	Negative	Wind	Medium	June–Nov.	N. J. to O., Kans. and Fla.	Harmless in hayfever.
Acer drummondii	Hard maple	Smooth; spherical	45	Mild	Wind	Very large	Mar.–April	Mo. to Ga., Fla. and Tex.	Occasional cause of early hayfever.
Acer negundo	Box elder	Smooth; ovoid	25 x 40	Mild	Wind	Very large	April–May	Me. and Ont. to Manitoba, south to Mex., Fla. and Tex.	Local cause of hayfever.
Acer rubrum	Red maple	Smooth; spherical	40	Mild	Wind	Very large	Mar.–April	Nova Scotia to Nebr., Fla. and Tex.	Occasional cause of mild early hayfever.
Acnida tamariscina	Western water-hemp	Smooth; spherical	25	Mild	Wind	Very large	July–Sept.	Ill. to Dak., Tex. and N. Mex.	A minor cause of mild hayfever.
Ageratum	Floss flower	Spiculated; ovoid	15 x 20	Positive	Insect	Small	May–Sept.	Cultivated	Mild reaction on direct inhalation.
Allenrolfea occidentalia	Grease weed	Smooth; spherical	20	Medium	Wind	Very large	Mar.–Nov.	Calif., Ore. to Tex.	A cause of hayfever in Pacific and Rocky Mt. states.
Allium mutabile	Wild onion	Smooth; ovoid	20 x 35	Negative	Insect	Small	April–June	N. C., Neb., south to Fla. and Tex.	Harmless in hayfever.
Alternathera phyloxeroides	False clover	Smooth; ovoid	25 x 30	Slight	Insect	Small	July–Sept.	Southeastern states	Harmless in hayfever.
Amaranthus spinosus	Spiny amaranth	Smooth; spherical	20	Mild	Wind	Large	June–Sept.	Me. to Minn., Fla. and Tex.	Accessory cause of mild hayfever.
Amaryllis	Striped lily	Spiculated; ovoid	30 x 55	Negative	Insect	Small	June–July	Cultivated	Harmless in hayfever.
Ambrosia elatior	Common ragweed	Spiculated; spherical	15	Very active	Wind	Profuse	Aug.–Oct.	Nova Scotia to Fla. west to Kans.	Principal cause of autumnal hayfever east of Kansas.

Ambrosia psilostachya	Western ragweed	Spiculated; spherical	26	Very active	Wind	Large	July–Oct.	Ill. to Saskat., Tex., Mex., Cal. and La.	Important hayfever weed west of Kans.
Ambrosia trifida	Giant ragweed	Spiculated; spherical	20	Very active	Wind	Profuse	Aug.–Oct.	Quebec to Fla. west to Neb., Colo. and N. Mex.	Important cause of autumnal hayfever.
Andropogon halepensis	Johnson grass	Smooth; spherical	45	Positive	Wind	Very large	June–Sept.	N. J., Ky., E. Kans. and Ariz. south to Fla. and Tex.	Common cause of early hayfever.
Anthemis tinctoria	Marguerite	Spiculated spherical	50	Positive	Insect	Small	June–Sept.	In gardens and fields	Hayfever only on direct inhalation.
Anthirrhinum	Snapdragon	Smooth; ovoid	20 x 36	Negative	Insect	Small	April–June	Cultivated	Harmless in hayfever.
Apium peptophyllum	Wild celery	Smooth; ovoid	10 x 30	Negative	Insect	Small	May–July	Southern states	Harmless in hayfever.
Artemisia absinthium	Absinth	Smooth; 3-lobed	22 x 28	Severe	Wind	Large	July–Oct.	N. Y. to Mass., Pa., N. C., Dak. and Mont.	A minor cause of severe hayfever.
Artemisia biennis	Biennial wormwood	Spiculated; spherical	15	Positive	Wind	Large	Aug.–Oct.	Manitoba to Nova Scotia, Mo., Ky. and Del.	A cause of typical hayfever.
Artemisia dracunculoides	Indian hair tonic	Smooth; 3-lobed	14	Severe	Wind	Very large	June–Sept.	Manitoba to British Col., Ill., Mo., Neb., Tex. and Calif.	Common cause of hayfever in the Pacific and Rocky Mt. states.
Artemisia frigida	Wormwood sage	Smooth; 3-lobed	20	Severe	Wind	Very large	July–Oct.	Minn., Ida., Neb., Tex. and Ariz.	A cause of hayfever west of Kans., also found at high altitudes (6000 ft.).
Artemisia heterophylla	Mugweed	Smooth; 3-lobed	22	Severe	Wind	Very large	July–Oct.	Calif. to British Col. and Nev.	Important hayfever weed west of Kans.
Artemisia ludoviciana	Dark-leaved mugwort	Smooth 3-lobed	18	Severe	Wind	Very large	July–Oct.	Calif. and Rocky Mt. states	Common cause of hayfever in Pacific and Rocky Mt. states.
Artemisia spinescens	Budbrush	Smooth; 3-lobed	14	Severe	Wind	Very large	Mar.–June	Calif. to Ore., Wyo. and Colo.	Common cause of hayfever in Pacific and Rocky Mt. states.

PLANTS TESTED FOR HAYFEVER REACTION AT THE BIOLOGICAL LABORATORY OF THE AMERICAN HAYFEVER PREVENTION ASSOCIATION.—(*Continued.*)

Botanical names.	Principal common name.	Surface of pollen.	Size in microns.	H-F. reaction.	Pollination.	Amount of pollen.	Seasons of bloom.	Geographical distribution.	Remarks.
Artemisia tridentata	Sagebrush	Smooth; 3-lobed	22	Severe	Wind	Very large	July–Sept.	Neb. to Colo., Utah and Calif. north to Minn.	Important cause of hayfever in Rocky Mt. states.
Aster ericoides	Michaelmas daisy	Spiculated; spherical	15	Positive	Insect	Small	Sept.–Dec.	Ohio to Caro. and Mich.	Hayfever on direct inhalation only.
Aster novæ angliæ	New England aster	Spiculated; spherical	18	Positive	Insect	Small	Aug.–Oct.	S. C., Ala., Kans. and Colo.	Hayfever on direct inhalation only.
Atriplex patula	Halberd-leaved Orache	Smooth; spherical	20	Mild	Wind	Abundant	Aug.–Oct.	Nova Scotia to S. C., Ohio and Mo., Neb., Utah and Pacific coast	Causes mild form of hayfever where abundant.
Avena sativa	Oats	Smooth; spherical	35	Positive	Wind	Abundant	May–June	Cultivated	A cause of early hayfever.
Azalia nudiflora	Bush honeysuckle	Smooth; ovoid	20 x 30	Negative	Insect	Small	April–May	Mass. and Ill. to Fla. and Tex.	Harmless in hayfever.
Balsam (*impatiens*)	Lady's slipper	Smooth; ovoid	22 x 30	Negative	Insect	Small	May–Sept.	Cultivated	Harmless in hayfever.
Begonia semperflorens	Begonia	Smooth; ovoid	15 x 30	Positive	Insect	Small	May–Sept.	Cultivated	Slight reaction only on direct inhalation.
Bœhmeria cylindrica	False nettle	Smooth; spherical	28	Mild	Wind	Abundant	July–Sept.	Canada to Minn., Fla., Kans. and Tex.	Occasional cause of mild hayfever.
Brassica nigra	Wild mustard	Smooth; ovoid	35 x 50	Negative	Insect	Small	May–June	Naturalized from Europe in United States generally	Harmless in hayfever.
Capriola dactylon	Bermuda grass	Smooth; spherical	25	Positive	Wind	Abundant	June–July	Mass. and N. Y. to Mo., Fla. and Mex.	A cause of early hayfever.

Celtis Mississippiensis	Hackberry	Smooth; spherical	25	Mild	Wind	Very large	April	Va. to Ill. and Mo. south to Fla. and Tex.	Local cause of hayfever.
Centaurea cyanus	Cornflower	Smooth; ovoid	20 x 40	Positive	Insect	Small	July–Sept.	Quebec to Ont., N. Y., Neb. and Va.	Hayfever only on direct inhalation.
Chætochloa glauca	Yellow fox-tail grass	Smooth; spherical	40	Positive	Wind	Large	July–Sept.	North America generally except extreme north	Common cause of early hayfever.
Chætochloa magna	Giant fox-tail grass	Smooth; spherical	26	Positive	Wind	Large	July–Aug.	Del. and Va. to Fla. and Tex.	Occasional cause of hayfever.
Chenopodium album	White goose-foot; lamb's quarters	Smooth; spherical	19	Mild	Wind	Large	June–Sept.	Common throughout North America except extreme north	A cause of mild hayfever.
Chenopodium ambrosioides	Mexican tea	Smooth; spherical	20	Mild	Wind	Large	Aug.–Oct.	Me. to Fla. west to Calif.	A cause of mild hayfever.
Chrysanthemum maximum	Shasta daisy	Spiculated; spherical	50	Positive	Insect	Small	June–July	Cultivated	Causes hayfever only on direct inhalation.
Chrysanthemum leucanthemum	Ox-eye daisy	Spiculated; spherical	24	Positive	Insect	Small	May–Nov.	Common throughout north; less abundant in south and west	Hayfever only on direct inhalation.
Chrysopsis graminifolia	Golden aster	Spiculated; spherical	30	Positive	Insect	Small	Aug.–Oct.	Del. to Fla., Ohio, Ken., Ark., Tex. Mex.	Hayfever only on direct inhalation.
Cinnamonum camphora	Camphor tree	Smooth; ovoid	15 x 25	Negative	Insect	Small	March	Popular shade tree in subtropical cities	Harmless in hayfever.
Cirsium lanceolatum	Horse thistle	Smooth; ovoid	20 x 30	Negative	Insect	Small	June–Oct.	Newfoundland to Ga., Minn., Neb., Ore. and Calif.	Harmless in hayfever.
Cirsium muticum	Swamp thistle	Spiculated; ovoid	42 x 58	Negative	Insect	Medium	July–Oct.	Newfoundland to Fla. and Tex.	Harmless in hayfever.
Clematis virginiana	Virgin's bower	Smooth; spherical	25	Negative	Insect	Small	July–Sept.	Ga. to Tenn. northward to Nova Scotia	Harmless in hayfever.

PLANTS TESTED FOR HAYFEVER REACTION AT THE BIOLOGICAL LABORATORY OF THE AMERICAN HAYFEVER PREVENTION ASSOCIATION.—(*Continued.*)

Botanical names.	Principal common name.	Surface of pollen.	Size in microns.	H-F. reaction.	Pollination.	Amount of pollen.	Seasons of bloom.	Geographical distribution.	Remarks.
Comptonia perigrina	Sweet fern	Smooth; ovoid	35 x 40	Negative	Insect	Small	April–May	Nova Scotia to Saskatchewan south to N. C., Ind. and Mich.	Harmless in hayfever.
Cratægus Marshallii	Parsley haw	Smooth; ovoid	20 x 40	Negative	Insect	Small	Mar.–April	Va. to Fla., Mo. and Tex.	Harmless in hayfever.
Cryptomeria japonica	Cedar of Lebanon	Smooth; spherical	24	Negative	Wind	Very large	Mar.–April	Cultivated from New England to Fla.	Harmless in hayfever.
Cucurbita pepo	Pumpkin	Smooth; spherical	50	Negative	Insect	Small	June–July	Cultivated	Harmless in hayfever.
Cupressus macrocarpa	Monteray cyprus	Smooth; spherical	22	Negative	Wind	Large	Mar.–April	Pacific coast	Harmless in hayfever.
Cyperus compressus	Flat cyperus	Smooth; spherical	25	Negative	Wind	Medium	Aug.–Sept.	N. Y. to Fla. west to Mo. and Tex.	Harmless in hayfever.
Cyperus rotundus	Nut grass (sedge)	Smooth; prismatic	22	Negative	Wind	Large	July–Sept.	Va. to Fla., Mo., Kans. and Tex.	Accused of causing hayfever, but it is harmless.
Cyperus strigosus	Straw-colored cyperus (sedge)	Smooth; prismatic	18 x 20	Negative	Wind	Large	May-Aug.	Me. to Minn., Fla. and Texas	Accused of causing hayfever, but it is harmless.
Cyperus virens	Evergreen cyperus (sedge)	Smooth; ovoid	20 x 25	Negative	Wind	Medium	Aug.–Oct.	N. Y. to Fla. west to Mo. and Tex.	Accused of causing hayfever, but it is harmless.
Dahlia	Dahlia	Spiculated; spherical	40	Positive	Insect	Small	June–Oct.	Cultivated	Mild reaction on direct inhalation.
Datura stramonium	Jimson weed	Smooth; spherical	18	Positive	Insect	Small	June–Sept.	Nova Scotia to Fla., west to Minn. and Tex.	Reaction only on direct inhalation.

Daucus carcta	Wild carrot	Smooth; spherical	26	Negative	Insect	Small	June–Sept.	Common in North America	Harmless in hayfever.
Delphinum carolinianum	Carolina larkspur	Smooth; ovoid	14 x 32	Negative	Insect	Small	May–June	Va. to Mo., Fla. and Tex.	Harmless in hayfever.
Dianthus chinensis	Chinese pink	Smooth; spherical	40	Positive	Insect	Small	June–Aug.	Cultivated	Hayfever only on direct inhalation.
Dianthus caryophyllis	Carnation pink	Smooth; spherical	50	Positive	Insect	Very small	June–Sept.	Cultivated	Hayfever only on direct inhalation.
Dolichus	Flowering bean	Smooth; ovoid	30 x 35	Negative	Insect	Small	June–July	Cultivated	Harmless in hayfever.
Dracopis amplexicaulis	Black-eyed Susan	Spiculated; ovoid	25 x 35	Active	Insect	Medium	June–Aug.	Mo. to Okla., La. and Tex.	Causes hayfever only on direct inhalation.
Eichhornia azurea	Water hyacinth	Smooth; ovoid	5 x 25	Negative	Insect	Small	June–Aug.	Southern states (ponds and edges of streams)	Harmless in hayfever.
Erianthus compactus	Plume grass	Smooth; spherical	28	Positive	Wind	Abundant	Sept.	N. J. to Fla. and Tex.	A minor cause of early hayfever.
Erigeron canadensis	Horse weed	Spiculated; ovoid	17 x 24	Positive	Wind	Large	June–Nov.	Common throughout North America except extreme north	Contributory cause of hayfever.
Erigeron strigosus	Daisy fleabane	Spiculated; ovoid	15 x 20	Positive	Insect	Small	May–Nov.	Nova Scotia to British Col., Fla., Tex. and Calif.	Frequent cause of hayfever in children from direct inhalation.
Erigeon pulchellus	Robin's plantain	Spiculated; spherical	24	Positive	Insect	Small	April–June	Me. to Ont., Minn., Kans., Fla. and La.	Hayfever on direct inhalation.
Erythrina arborea	Coral tree	Smooth; triangular	30	Positive	Insect	Small	May–June	In southern parks and gardens	Hayfever on direct inhalation.
Eupatorium serotinum	Thoroughwort	Spiculated; ovoid	18 x 21	Positive	Wind and insect	Medium	Sept.–Nov.	Del. to Fla., Minn., Iowa, Kans. and Tex.	Cause of hayfever, but is not sufficiently abundant to be of importance.
Eupatorium sessilifolium	Upland boneset	Spiculated; spherical	20	Positive	Insect	Medium	Aug.–Oct.	Vt. to Mass., Pa., Ga., Ala. and Mo.	Hayfever only on direct inhalation.

PLANTS TESTED FOR HAYFEVER REACTION AT THE BIOLOGICAL LABORATORY OF THE AMERICAN HAYFEVER PREVENTION ASSOCIATION.—(*Continued.*)

Botanical names.	Principal common name.	Surface of pollen.	Size in microns.	H-F. reaction.	Pollination.	Amount of pollen.	Seasons of bloom.	Geographical distribution.	Remarks.
Fœniculum fœniculum	Sweet fennell	Smooth; ovoid	15 x 30	Slight	Insect	Small	July–Sept.	Conn. to Pa., Va., Mo. and La.	May cause mild reaction on direct inhalation.
Franseria acanthicarpa	False ragweed	Spiculated; spherical	15	Positive	Wind	Large	July–Sept.	Saskatchewan to Neb. and Tex. west to British Columbia, Calif.	Common cause of hayfever in the Pacific and Rocky Mt. states.
Franseria dumosa	Sandbur	Spiculated; spherical	18	Positive	Wind	Large	Mar.–June	Utah to Calif. and Ariz.	Common cause of hayfever in the Pacific and Rocky Mt. states.
Fraximus americana	White ash	Smooth; spherical	20	Mild	Wind	Very large	May–June	Nova Scotia to Ont., Minn., Fla., Kans. and Tex.	Local cause of hayfever.
Gærtneria bipennatifida	Gærtneria	Spiculated; spherical	18	Active	Wind	Large	April–Dec.	Seashore from Calif. to British Col.	Common cause of hayfever in the Pacific states.
Gærtneria tenuifolia	Slender-leaved gærtneria	Spiculated; spherical	15	Active	Wind	Large	July–Sept.	Miss. Valley to Colo., Nev. and Calif.	A cause of hayfever west of Kansas.
Gladiolus	Gladiolus	Smooth; ovoid	40 x 70	Negative	Insect	Small	May–June	Cultivated	Harmless in hayfever.
Gnaphalium helleri	Life everlasting	Smooth; spherical	23	Negative	Insect	Small	Sept.–Oct.	N. Y. and N. J. to Va., Ky. and Ga.	Harmless in hayfever.
Gossypium peruvianum	Cotton	Spiculated; spherical	110	Positive	Insect	Small	June–July	Southern states	Negligible in hayfever on account of large size of pollen.

Grindelia squarrosa	Resin wood	Spiculated; spherical	20	Positive	Contact	Small	June–Sept.	Ill. and Minn. to Mo., Ariz.; adventive in N. J., Pa. and N. Y.	In spite of popular belief in certain sections it does not cause hayfever.
Hartmannia speciosa	Showy primrose	Smooth; triangular	110	Negative	Insect	Small	April–June	Miss. and Kans. to La., Tex., Ariz. and Mexico	Harmless in hayfever.
Helenium quadridentatum	Sneezeweed	Spiculated; spherical	25	Very active	Insect	Small	July–Oct.	Va., Fla., Mo., Kans. and Tex.	Causes hayfever only on direct inhalation.
Helianthus annuus	Common sunflower	Spiculated; spherical	40	Very active	Insect and wind	Medium	July–Sept.	Minn. to N. Dak., Ida., Mo., Tex. and Calif.	Causes hayfever only in close proximity.
Helianthus lætiflorus	Showy sunflower	Spiculated; ovoid	22 x 30	Positive	Insect	Small	Aug.–Sept.	Pa. to Minn. and in cultivation	Hayfever only on direct inhalation.
Helianthus parviflorus	Small-flowered sunflower	Spiculated; spherical	22	Positive	Insect	Medium	July–Sept.	Pa. to Ga. west to Mo. and La.	Hayfever only on direct inhalation.
Helianthus giganteus	Tall sunflower	Spiculated; spherical	35	Positive	Insect	Medium	Aug.–Oct.	Me. to Fla., La. and Colo.	Hayfever only on direct inhalation.
Helianthus angustifolius	Perennial sunflower	Spiculated; spherical	40	Positive	Insect	Medium	Aug.–Oct.	Long Island to Fla., Ky. and Tex.	Hayfever only on direct inhalation or close proximity.
Hemerocallis	Day lily	Smooth; ovoid	30 x 80	Negative	Insect	Small	June–Aug.	Cultivated	Harmless in hayfever.
Hibiscus esculentus	Okra	Spiculated; spherical	170	Positive	Insect	Small	June–Sept.	Cultivated	Negligible on account of large size of pollen.
Hibiscus palustris	Marshmallow	Spiculated; spherical	170	Positive	Insect	Small	Aug.–Sept.	Mass. to Fla. to La., Ind. and Mo.	Negligible on account of large size of pollen.
Hibiscus syriacus	Rose of Sharon	Spiculated; spherical	160	Positive	Insect	Small	July–Sept.	Cultivated; adventive in Conn. to Pa. and Ga.	Hayfever only on direct inhalation.
Hicoria ovata	Hickory	Smooth; spherical	35	Positive	Wind	Abundant	May	Quebec to Ont. to Fla. and Tex.	Accessory cause of early hayfever.
Homalocenchrus virginicus	White grass	Smooth; spherical	26	Positive	Wind	Large	Aug.–Sept.	Me. to Ont., Fla. and Tex.	Minor cause of hayfever.

PLANTS TESTED FOR HAYFEVER REACTION AT THE BIOLOGICAL LABORATORY OF THE AMERICAN HAYFEVER PREVENTION ASSOCIATION.—(*Continued.*)

Botanical names.	Principal common name.	Surface of pollen.	Size in microns.	H-F. reaction.	Pollination.	Amount of pollen.	Seasons of of bloom.	Geographical distribution.	Remarks.
Hydrangea	Hydrangea	Smooth; ovoid	15 x 20	Positive	Insect	Small	June–July	In gardens generally	Hayfever only on direct inhalation.
Hymenochlæa salsola	Greaseweed	Smooth; spherical	20	Mild	Wind	Large	July–Sept.	Calif., Ariz. and Nev.	Minor cause of hayfever in the Pacific and Rocky Mt. states.
Ibaris umbellata	Candy tuft	Smooth; ovoid	10 x 30	Negative	Insect	Small	June–Sept.	Cultivated	Harmless in hayfever.
Ilex decidua	Meadow holly	Smooth; spherical	14	Negative	Insect	Small	April–May	Dist. of Col. to Fla. west to Ill., Kans. and Tex.	Harmless in hayfever.
Ilex opaca	American holly	Rough; 3-lobed	20 x 30	Negative	Insect	Small	April–June	Mass. to Fla., Pa., Ind., Mo. and Tex.	Harmless in hayfever.
Ipomœa purpurea	Morning glory	Spiculated; spherical	75	Positive	Insect	Small	June–Oct.	Nova Scotia to Fla. west to Ont., Neb. and Tex.	Occasional reaction from direct inhalation.
Iris kæmpferi	Japanese iris	Smooth; ovoid	25 x 70	Negative	Insect	Small	June–July	Cultivated	Harmless in hayfever
Iva axillaris	Poverty weed	Spiculated; spherical	20	Positive	Wind	Large	May–Sept.	Manitoba and N. Dak. to Neb., N. Mex. and Calif.	Common cause of hayfever in the Pacific and Rocky Mt. states.
Iva ciliata	Rough marsh elder	Spiculated; spherical	25	Active	Wind	Profuse	Aug.–Oct.	Ill. to Neb., La. and N. Mex.	A cause of hayfever.
Iva xanthiifolia	Burweed marsh elder	Spiculated: ovoid	15 x 20	Positive	Wind	Large	July–Sept.	Wis., Neb., N. Mex. and Utah	Important cause of hayfever west of Kansas.

Juglans nigra	Black walnut	Smooth; spherical	40	Positive	Wind	Abundant	April–May	Mass., Ont. and Minn. to Tex. and Fla.	A local cause of early hayfever.
Juniperus sabinoides	Mountain cedar	Smooth; spherical	15	Positive	Wind	Abundant	Feb.–Mar.	Tex. to Mexico	A cause of early spring hayfever.
Juniperus virginiana	Red cedar	Smooth; spherical	20	Positive	Wind	Abundant	April–May	Nova Scotia to Ont. and S. Dak. south to Fla. and Tex.	Occasional cause of early hayfever.
Jussiœa repens	Primrose willow	Smooth; ovoid	32 x 42	Negative	Insect	Small	June–Aug.	Ky. and Ill. to Kans., Fla and Tex.	Harmless in hayfever.
Kalmia latifolia	Mountain laurel	Smooth; 3-lobed	25	Negative	Insect	Small	May–June	New B. to Ont., Ind., Ky., Fla. and La.	Harmless in hayfever.
Lagerstrœmia indica	Crepe myrtle	Smooth; ovoid	22 x 31	Negative	Insect	Small	April–May	From Md. southward	Harmless in hayfever.
Lathyrus odoratus	Sweet pea	Smooth; cylindrical	20 x 40	Mild	Insect	Small	April–May	Gardens	Harmless in hayfever.
Leontodon taraxacum	Dandelion	Spiculated hexagonal	46	Marked	Insect	Small	Jan.–Dec.	All parts of the world	Causes reaction only on direct inhalation.
Lepidium virginicum	Pepper grass	Smooth; ovoid	10 x 25	Negative	Insect	Small	May–Nov.	Quebec to Minn., Colo., Fla. and Tex.	Harmless in hayfever.
Leptochloa filiformis	Feather grass	Smooth; spherical	20	Positive	Wind	Abundant	June–July	Va. to Ill. and Calif. south to Fla. and Mexico	Accessory cause of early hayfever.
Ligustrum vulgare	Common privet	Smooth; ovoid	20 x 25	Negative	Insect	Small	May–June	Me., N. Y. to Fla. and Tex.	Harmless in hayfever.
Ligustrum amurense	Japanese privet	Smooth; ovoid	23 x 37	Negative	Insect	Small	June–July	Cultivated	Harmless in hayfever.
Ligustrum napalense	Evergreen privet	Smooth; ovoid	25 x 35	Negative	Insect	Small	June–July	Cultivated	Harmless in hayfever.
Lilium candidum	Madonna lily	Smooth; 4-lobed; ovoid	60 x 80	Negative	Insect	Small	May-June	Cultivated	Harmless in hayfever.
Lilium martagon	Spotted lily	Smooth; ovoid	50 x 100	Negative	Insect	Small	May	Cultivated	Harmless in hayfever.

PLANTS TESTED FOR HAYFEVER REACTION AT THE BIOLOGICAL LABORATORY OF THE AMERICAN HAYFEVER PREVENTION ASSOCIATION.—(*Continued.*)

Botanical names.	Principal common name.	Surface of pollen.	Size in microns.	H-F. reaction.	Pollination.	Amount of pollen.	Seasons of bloom.	Geographical distribution.	Remarks.
Liquidambar styraciflua	Sweet gum	Smooth; spherical	30	Negative	Wind	Abundant	April–May	Conn. and N. Y. to Fla., Ill., Mo. and Mexico	Harmless in hayfever.
Lonicera flava	Yellow honeysuckle	Spiculated; spherical	55	Mild	Insect	Small	May	N. C. to Ky., Mo., Ga. and Ala.	Causes mild reaction only on direct inhalation.
Magnolia virginiana	Laurel magnolia	Smooth; ovoid	45 x 83	Negative	Wind; insect	Abundant	May–June	Eastern and southern states	Harmless in hayfever.
Medeola virginiana	Indian cucumber	Smooth; ovoid	20 x 35	Negative	Insect	Small	May–June	Nova Scotia to Ont., Minn., Fla. and Tenn.	Harmless in hayfever.
Medicago hispida	Bur clover	Smooth; ovoid	18 x 40	Negative	Insect	Small	Summer	Nova Scotia to Pa., Fla., Neb., Tex. and Pacific coast.	Harmless in hayfever.
Melia azederach	China-ball tree	Smooth; spherical	30	Negative	Insect	Small	April	Southern states	Harmless in hayfever.
Melilotus indica	Yellow millet	Smooth; ovoid	12 x 20	Negative	Insect	Small	May–Oct.	Sea-ports and far west	Harmless in hayfever.
Mimosa strigillosa	Trailing mimosa	Smooth; spherical	6	Negative	Insect	Small	June–July	Southeastern states	Harmless in hayfever.
Mirabilis	Four o'clock	Spiculated; spherical	185	Negative	Insect	Small	June–Oct.	Cultivated	Harmless; one of the largest pollens investigated.
Morus alba	White mulberry	Smooth; spherical	19	Negative	Wind	Abundant	May	Me. and Ont. to Fla.	Harmless in hayfever.
Nasturtium montanum	Mountain cress	Smooth; ovoid	20 x 40	Negative	Insect	Small	April–June	In southeastern states	Harmless in hayfever.

Nasturtium sessiliflorum	Sessile-flowered cress	Smooth; ovoid	15 x 30	Negative	Insect	Small	April–June	Va. to Ill., Iowa, Neb., Ark., Fla. and Tex.	Harmless in hayfever.
Nymphæa capensis	Water lily	Smooth; spherical	30	Negative	Insect	Small	June–Aug.	Cultivated (ponds)	Harmless in hayfever.
Œnothera biennis	Evening primrose	Smooth; triangular	130	Negative	Insect	Small	June–Oct.	Fla., Minn., Ark. and Tex.	Harmless in hayfever.
Osmunda cinnamonea	Cinnamon fern	Spiculated; ovoid	25 x 53	Negative	Wind	Abundant	May–June	Newfoundland to Minn., gulf states and N. Mex.	Spores harmless in hayfever.
Oxalis corniculata	Yellow wood-sorrel	Smooth; ovoid	20 x 22	Negative	Insect	Small	April–Oct.	Southern states	Harmless in hayfever.
Oxydendron arboreum	Sour-wood	Smooth; 3-lobed	25	Negative	Insect	Small	May–June	New Brunswick to Ont., Ind., Ky., Fla. and La.	Harmless in hayfever.
Pæonia	Peony	Smooth; ovoid	25 x 35	Negative	Insect	Small	May–June	Cultivated	Harmless in hayfever.
Panicum crus-galli	Cockspur grass	Smooth; spherical	26	Positive	Wind	Abundant	Aug.–Oct.	North America generally	A cause of early hayfever.
Panicum repens	Marsh grass	Smooth; spherical	47	Positive	Wind	Large	July	Salt marshes of southern states	Occasional cause of hayfever.
Papaver	Poppy	Smooth; 3-lobed; ovoid	30 x 35	Negative	Insect	Small	June–July	Cultivated	Harmless in hayfever.
Parkensonia aculeata	Parkensonia	Smooth; ovoid	20 x 24	Negative	Insect; wind	Medium	April–May	Cultivated in gulf states	Harmless in hayfever.
Parthenium hysterophorus	False wormwood	Spiculated; spherical	20	Positive	Wind	Medium	July-Sept.	Pa. to Ill., Mo., Fla. and Tex.; throughout tropical America	In some sections this is a perennial bloomer and may cause hayfever at any season.
Paspalum vasyanum	Small bull grass	Smooth; spherical	26	Positive	Wind	Abundant	Aug.–Sept.	Va. and Tenn. to Fla. and Tex.	Common cause of early hayfever.
Paspalum dilatum	Tall bull grass	Smooth; spherical	30	Positive	Wind	Large	June–Sept.	Va. and Tenn. to Fla. and Texas	Important cause of early hayfever.
Petunia	Petunia	Smooth; ovoid	20 x 45	Negative	Insect	Small	June–Sept.	Cultivated	Harmless in hayfever.

PLANTS TESTED FOR HAYFEVER REACTION AT THE BIOLOGICAL LABORATORY OF THE AMERICAN HAYFEVER PREVENTION ASSOCIATION.—(*Continued.*)

Botanical names.	Principal common name.	Surface of pollen.	Size in microns.	H-F. reaction.	Pollination.	Amount of pollen.	Seasons of bloom.	Geographical distribution.	Remarks.
Philadelphus coronarius	Syringa	Smooth; ovoid	10 x 20	Positive	Insect	Small	May–June	Naturalized in Va. and Ohio, and partially in eastern and southern sts.	Hayfever on direct inhalation.
Phœnix	Date palm	Smooth; ovoid	23 x 50	Negative	Wind	Large	June	Cultivated	Harmless in hayfever.
Pieris floribunda	Fetter bush	Smooth; 3-lobed	30	Negative	Insect	Small	May	Ga. and N. C.	Harmless in hayfever.
Pinus coulteri	Coulter's pine	Smooth; winged	58	Negative	Wind	Abundant	April	Coast range of Calif.	Harmless to hayfever.
Pinus palustris	Long-leaf pine	Smooth; spherical (winged)	40	Negative	Wind	Very abundant	Mar.–April	Va. to Ala., Fla. and Tex.	Negative in hayfever.
Pisum sativum	Peas (vegetable)	Smooth; spherical	40	Negative	Insect	Small	May–July	Cultivated	Harmless in hayfever.
Plantago lanceolata	Lance-leaved plantain	Smooth; spherical	13	Mild	Wind; insect	Medium	April–Nov.	Northwest Fla. and Kans.	Occasional cause of mild hayfever.
Plantago rugelii	Rugel's plantain	Smooth; spherical	32	Mild	Wind	Medium	June–Sept.	S. Dak., Fla., and Kans.	Occasional cause of mild hayfever.
Plumbago larpentæ	Leadwort	Smooth; ovoid	50 x 70	Negative	Insect	Small	June–Sept.	Cultivated	Harmless in hayfever.
Poa annua	Annual meadow grass	Smooth; spherical	24	Positive	Wind	Abundant	May–Oct.	Throughout North America	Common cause of early hayfever.
Pontederia cordata	Pickerel weed	Smooth; ovoid	20 x 50	Negative	Insect	Small	June–Oct.	Nova Scotia to Minn., La. to Fla. and Tex.	Harmless in hayfever.
Populus arizonica	Arizona cottonwood	Smooth; spherical	24	Mild	Wind	Abundant	Feb.–April	Ariz. to Cal. and Nev.	Local cause of hayfever.

Populus deltoides	Yellow cottonwood	Smooth; ovoid	22 x 32	Positive	Wind	Abundant	April–May	Quebec to Manitoba, south to Conn., Fla. and Tenn.	Local cause of hayfever
Polygonum persicaria	Lady's thumb	Smooth; spherical	45	Mild	Wind; insect	Medium	June–Oct.	Common almost throughout North America except in extreme north.	Occasional cause of mild hayfever.
Polygonum aviculare	Knot grass	Smooth; spherical	17	Mild	Wind; insect	Medium	June–Oct.	Common almost throughout North America	Occasional cause of mild hayfever.
Potentilla simplex	Five-finger	Smooth; ovoid	10 x 15	Negative	Insect	Small	May–July	Nova Scotia to N. C., Ala., Me. and Mo.	Harmless in hayfever.
Prosopis glandulosa	Prairie mesquite	Smooth; ovoid	20 x 50	Negative	Insect; wind	Medium	April–June	Kans. to Tex., Ariz., Calif. and Mexico	Harmless in hayfever.
Prunus carolinensis	Carolina plum	Smooth; ovoid	22 x 30	Negative	Wind	Abundant	April–May	Southeastern states	Harmless in hayfever.
Prunus avium	Wild cherry	Smooth; ovoid	12 x 23	Negative	Insect; wind	Medium	April–May	Ont. to Conn., Pa. and Va.	Harmless in hayfever.
Punica	Pomegranate	Smooth; 3-lobed	35	Negative	Mild	Small	June–July	Cultivated	Harmless in hayfever.
Pyrus japonica	Flowering crabapple	Smooth; triangular	30	Negative	Wind; insect	Medium	March	Cultivated	Harmless in hayfever.
Quamoclit coccinea	Red morning glory	Spiculated; spherical	115	Positive	Insect	Small	June–Oct.	R. I. to Pa., Fla., Ohio, Tex., Ariz.	Hayfever only on direct inhalation.
Quercus nigra	Water oak	Smooth; ovoid	18 x 34	Medium	Wind	Abundant	April–May	Del. to Ky., Mo., Fla. and Tex.	Local cause of early hayfever.
Quercus virginiana	Live oak	Smooth; ovoid	16 x 30	Medium	Wind	Abund-	Mar.–April	Va. to Fla., Tex. and Mexico	Local cause of early hayfever.
Radicula montana	Yellow cress	Smooth; ovoid	12 x 30	Negative	Insect	Small	May–Sept.	Southeastern states	Harmless in hayfever.
Raphanus sativus	Radish	Smooth; ovoid	20 x 35	Negative	Insect	Small	May–Sept.	Cultivated	Harmless in hayfever.
Ranunculus muricatus	Spiny-leaved crow-foot	Smooth; spherical	30	Negative	Insects	Small	June–Aug.	Va. to Ark., Fla. and Tex.	Harmless in hayfever.
Rhus typhina	Staghorn sumac	Smooth; ovoid	30 x 40	Mild	Insect	Medium	June	Nova Scotia to Ga. west to S. Dak., Ia. and N. H.	Negligible in hayfever.

PLANTS TESTED FOR HAYFEVER REACTION AT THE BIOLOGICAL LABORATORY OF THE AMERICAN HAYFEVER PREVENTION ASSOCIATION—(*Continued.*)

Botanical names.	Principal common name.	Surface of pollen.	Size in microns.	H–F. reaction.	Pollination.	Amount of pollen.	Seasons of bloom.	Geographical distribution.	Remarks.
Robinia pseudacacia	Locust tree	Smooth; ovoid	10 x 30	Negative	Insect	Medium	May–June	Pa. to Ga. west to Ia., Mo. and Okla.	Harmless in hayfever.
Rosa hybrida	Garden roses	Smooth; ovoid	20 x 26	Negative	Insect	Medium	April–Oct.	Cultivated	Its influence[1] in hayfever is a popular myth.
Rosa rubiginosa	Sweetbriar rose	Smooth; ovoid	15 x 30	Negative	Insect	Small	April–June	Va. to Fla., Tenn. and Miss.	Harmless in hayfever.
Rubus procumbens	Blackberry	Smooth; ovoid	10 x 30	Negative	Insect	Small	April–May	Ont. to Lake Superior south to Va., La. and Tex.	Harmless in hayfever.
Rubus neglectus	Wild raspberry	Smooth; ovoid	15 x 35	Negative	Insect	Small	May–July	Vt. to Ont., Pa. and Ohio	Harmless in hayfever.
Rudbekia lanciniata	Golden glow	Spiculated; spherical; ovoid	30	Positive	Insect	Small	June–Aug.	Cultivated	Hayfever only on direct inhalation.
Rumex crispus	Yellow dock	Smooth; spherical	25	Mild	Wind	Abundant	June–Aug.	Nearly throughout the United States	Minor cause of hayfever.
Rumex obtusifolius	Broad-leaved dock	Smooth; spherical	27	Mild	Wind	Small	June–Aug.	Ore., Fla. and Tex.	Minor cause of hayfever.
Sabal adamsonii	Palm	Smooth; ovoid	12 x 24	Negative	Wind	Abundant	March	Naturalized in southern states	Harmless in hayfever.
Sagittaria latifolia	Broad-leaved arrowhead	Smooth; spherical	20	Negative	Insect	Small	June–Sept.	North America generally	Harmless in hayfever.
Salix nigra	Black willow	Smooth; ovoid	20 x 32	Mild	Wind	Abundant	April–May	New B. to western Ont,. N. Dak., Fla. and Tex.	Occasional cause of early hayfever.
Salvia splendens	Flowering sage	Smooth; ribbed	42	Negative	Insect	Small	May–Oct.	Cultivated	Harmless in hayfever.

Sambucus canadensis	American elder	Smooth; ovoid	15 x 20	Negative	Insect	Small	June–July	Nova Scotia to Fla., Kans. and Tex.	Harmless in hayfever.
Sarcobatus vermicularis	Greaseweed	Smooth; spherical	28	Mild	Wind	Large	Sept.–Oct.	Neb., Wyo. to Nev. and N. Mex.	A cause of hayfever in the Rocky Mt. states.
Sarracenia pupurea	Ladies' slipper	Smooth; ovoid	12 x 23	Negative	Insect	Small	May–June	Canadian Rocky Mts., Fla., Ky. and Ind.	Harmless in hayfever.
Saururus cernuus	Lizard's tail	Smooth; ovoid	5 x 10	Negative	Insect	Small	June–Aug.	R. I. to Fla. west to Ont., Minn., Tex.	Harmless in hayfever.
Scirpus mucronatus	Bog bullrush	Smooth; spherical	20	Negative	Wind	Medium	July–Sept.	Pa.	Harmless in hayfever.
Scirpus americanus	Sword bullrush	Smooth; spherical	23	Negative	Wind	Abundant	June–Sept.	Temperate North America	Harmless in hayfever.
Scirpus validus	Great bullrush	Smooth; spherical	21	Negative	Wind	Abundant	July–Sept.	North America generally	Harmless in hayfever.
Senecio vulgaris	Groundsel	Spiculated; spherical	18	Positive	Insect	Small	April–Oct.	Newfoundland to Hudson Bay, N. C., Minn., Mich. and Pacific coast	Hayfever on direct inhalation.
Solanum carolinense	Horse nettle	Smooth; ovoid	20 x 30	Positive	Contact; insect	Small	June–July	Nova Scotia to Fla. west to Ill., Neb. and Tex.	Hayfever on direct inhalation.
Solidago canadensis	Canadian golden rod	Spiculated; ovoid	18 x 22	Positive	Insect	Medium	Aug.–Oct.	Va., Tenn. and S. Dak.	Hayfever[1] on direct inhalation or close proximity as from room decorations.
Solidago odora	Sweet scented golden rod	Spiculated; spherical	25	Positive	Wind	Medium	July–Sept.	N. H. to Fla., N. Y., Ky., Mo. and Tex.	Similar to *Solidago. canadensis*.
Sonchus asper	Sow thistle	Spiculated; spherical	30	Active	Insect	Small	May–Nov.	Widely distributed in all parts of the United States	Causes reaction only on direct inhalation.
Spirœa	Bridal wreath	Smooth; ovoid	8 x 12	Negative	Insect	Medium	April–May	Cultivated in gardens generally	Harmless in hayfever.
Sporobulus angustus	Smut grass	Smooth; spherical	25	Positive	Wind	Abundant	June–July	Va. to Fla. west to Mo. and Calif.	Common cause of early hayfever.
Trifolium pratense	Red clover	Smooth; ovoid	40 x 50	Negative	Insect	Small	April–Nov.	Common throughout north and south	Harmless in hayfever.

[1] Scheppegrell: Hayfever and its Prevention, U. S. Public Health Reports, July 21, 1916.

PLANTS TESTED FOR HAYFEVER REACTION AT THE BIOLOGICAL LABORATORY OF THE AMERICAN HAYFEVER PREVENTION ASSOCIATION.—(*Continued.*)

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Trifolium repens	White clover	Smooth; ovoid	25 x 30	Negative	Insect	Small	May–Dec.	Common throughout north, northwest and south	Harmless in hayfever.
Triticum vulgare	Wheat	Smooth; spherical	50	Positive	Wind	Large	July–Aug.	Cultivated	A cause of hayfever but potential area limited by large size of pollen.
Tropæolum	Nasturtium	Smooth; ovoid	20 x 24	Negative	Insect	Small	May–Oct.	Throughout North America	Harmless in hayfever.
Ulmus americana	American elm	Smooth; spherical	30	Positive	Wind	Abundant	Mar.–April	Newfoundland to Manitoba, Fla. and Tex.	Local cause of hayfever.
Vaccinium pallidum	Blueberry	Smooth; spherical	35	Negative	Insect	Small	May–June	Va. to S. C.	Harmless in hayfever.
Verbena hybrida	Verbena	Smooth; ovoid	35 x 50	Negative	Insect	Small	June–Sept.	Cultivated	Harmless in hayfever.
Vernonia noreboracensis	Iron weed	Spiculated; spherical	40	Positive	Insect	Small	July–Sept.	Mass. to Pa., N. C., W. Va., Miss. and Mo.	Hayfever only on direct inhalation.
Xanthium echinatum	Cockle bur	Spiculated; spherical	30	Positive	Wind	Abundant	Aug.–Sept.	N. C. to N. Y., Minn., N. Dak.	Minor cause of fall hayfever.
Xanthium pennsylvanicum	Cockle bur	Spiculated; spherical	36	Positive	Wind	Abundant	Aug.–Oct.	Minn. to N. Y., Mo., Colo (moist soil)	Less active reaction than the ragweed; large size of pollen limits potential area.
Zea mays	Corn	Smooth; spherical	80	Positive	Wind	Abundant	June–July	Cultivated	Restricted potential area on account of large size of pollen.
Zinnia	Old maid	Spiculated; spherical	18	Positive	Insect	Small	May–Aug.	Cultivated	Hayfever on direct inhalation only.

CHAPTER XX.

THE PREVENTION OF HAYFEVER.

EDUCATIONAL METHODS.

WHEN we realize the large number of persons affected with hayfever, and the great suffering which it entails, we can appreciate the importance of concerted efforts to prevent this disease. The first practical step in the work of prevention is the education of the public in the responsibility of pollens of weeds in causing hayfever. When it realizes that the common weeds are the cause of suffering to many persons, and that it may effect hayfever subjects living at a considerable distance, it will view these weeds from a new angle, and will encourage it to make use of one of the many ways of destroying them, or at least preventing them from reaching the stage of pollination.

In the educational part of this work the first consideration is the correct diagnosis of hayfever, and the acceptance of the fact that all cases of true hayfever are the results of pollen inhalation.

The identification of the various weeds and plants that may develop hayfever is of the utmost importance, but will gradually follow the establishing of the etiology of this disease. As these principles become better understood, the physician, when consulted by a patient with hayfever, instead of limiting his attention to writing a prescription or injecting a vaccine, will investigate the presence of hayfever-producing weeds in the neighborhood of the patient's residence (Fig. 104) or place of business. In many cases the eradication or even the cutting of such weeds will produce beneficial results.

In the case of one of our patients, the offending weed (*Ambrosia elatior*) was growing in his garden. In another, a

school teacher, affected with hayfever for many years, on being questioned stated that there was an abundance of flowering weeds in the vacant lots adjoining her house. When specimens of these weeds were produced, they were found to be the bastard feverfew (*Parthenium hysterophorus*), one of the causes of hayfever in South Louisiana. In both of these cases marked improvement soon followed the cutting of these weeds. In order to obtain complete relief in such cases, however, the cutting of the weeds should be over a considerable adjoining area, as the pollen is wind-borne to a distance depending on the velocity of the wind and the size of the pollen.

FIG. 104.—Neighborhood infested with hayfever weeds.

In 1917 the attention of the American Hayfever Prevention Association was called by a physician, in New York, to the use of the Mexican mugwort (*Artemisia mexicana*) for decorative purposes, and gave an illustration of the ease with which the seedlings of the plants, that were thrown out, were established and naturalized. As the wormwoods (*Artemisias*) are among the most noxious hayfever weeds, we at once called the attention of the New York State Board of Health to the risk of using these plants. We also wrote to the importer, who, upon learning the danger of

these plants from a hayfever standpoint, promptly promised to discontinue their distribution.

While the removal of the offending weed is the correct measure, relief may also be obtained, when this is impracticable, by avoiding the proximity of weeds to which the patient is sensitive. In many cases this is entirely practicable, as shown in the following case in which the usual attack was postponed for thirty-three days by this precaution.

The manager of a sugar plantation near New Orleans had been a sufferer from hayfever for the past ten years, the attacks always commencing about August 25. After the influence of the ragweed on this form of hayfever had been explained to him, he concluded that his attacks were due to the pollen of the giant ragweed, which grows on a road some distance from his residence. He therefore avoided this road, and until September 28, for the first time in ten years, he had had no attack. On this date he found it necessary to pass this road. In twenty minutes he commenced to sneeze; that night he had a violent attack, and the following day he had his usual hayfever.

The advice to patients regarding the eradication of hayfever-producing weeds will not only produce beneficial results, but will also prove a powerful impetus in educating the public in the relationship of such weeds to hayfever. It will result, moreover, in having these weeds considered from a new point of view. Instead of simply indicating neglect or careless cultivation, they will be looked on as a source of disease and discomfort to a large class of sufferers. This will not only bring the leverage of public opinion to the eradication of these weeds, but will eventually simplify the question of legislation.

In connection with the subject of public education, regarding hayfever, the American Hayfever Prevention Association has received a communication from Dr. Rupert Blue, while Surgeon-General of the United States Public Health Service, and honorary vice-president of this association, in which he summarizes this in a very concise manner:

"It appears that the most practical method of securing the coöperation of the public would be by education as to

the effect of the presence of these weeds in communities from both health and economic standpoints. This seems to be the primary object of your association, which is to be commended for its efforts."

CONTROL OF HAYFEVER WEEDS.

The various methods of controlling hayfever weeds is evidently a question of convenience and economy. On the farm the most effective is careful cultivation. Where this is not practicable, these weeds may be kept down by grazing cattle, and especially by sheep. When neither of these methods is available, the weeds should be destroyed or cut before they reach the flowering stage, as this will prevent both the pollinating, which causes the hayfever, and the formation of the seeds which propagate the plants. On the roadside, which is a favorite site for hayfever weeds, it is sometimes found to be more economical to use some form of chemical weed-killer. When these methods are persistently carried out for a few years, the results will justify the cost and the energy expended.

An important item in the control of hayfever weeds is the distance at which pollen may produce an attack of hayfever. It has been shown, by means of our atmospheric-pollen plates which are exposed to the wind, that some pollen may travel a great distance—even several miles. We have found, however, that pollen scatters rapidly as it is carried by the wind from the parent weed, the decrease being estimated to be inversely as the square of the distance. According to the above rule, a patient at 1000 feet, or about three ordinary city blocks, would inhale only one one-hundredth part of the pollen to which he would be exposed at 100 feet.

The efforts to destroy the weeds causing hayfever are not of recent origin, such as the attempts to eradicate the causes of typhoid fever, malaria and other diseases. Farming has been a necessity since the first efforts of civilization, and from this time the weeds have filled the trenches and hillocks of the land, and contested the efforts of the farmer.

The weeds that cause the greatest distress to the hayfever sufferer, such as the ragweeds, wormwoods, yellow dock, careless weed, marsh elder and cockle bur, are also among the most persistent enemies of the farmer and gardener.

So important is the subject of weeds and their extermination from the farmers' standpoint, that the State Departments of Agriculture devote much time to this subject. In an article on weeds, H. R. Cox, Agriculturist of the Office of Farm Management, makes the following introductory statement, which, while entirely from an agricultural view, fully represents the subject from the standpoint of public health.

"In a sense, farming might be called a warfare against weeds. Some farmers emerge from the struggle victorious, while others go down to defeat. So powerful are weed enemies in reducing crop yields, while at the same time multiplying labor, that the farmer should at every turn strengthen his position against them. He should bear these invaders in mind in planning the crops he will grow and in deciding on the fields where he will grow these crops, in choosing the implements he will use, in buying his seed, and in many other farm activities. Lack of careful planning with reference to weeds is apparent in nearly every community. Here a man planted out more corn that he could properly care for. There a man has left his field in meadow too many years. Here a man did not thoroughly prepare his land for alfalfa. There a man has seeded clover that was full of weed seeds. And for just such causes weeds not only make serious inroads on the current crop yields, but at the same time thoroughly infest the land and fortify themselves against future attacks.

"The importance of keeping weeds in subjection cannot be emphasized too strongly. It has been shown in experiments with corn made by the Department of Agriculture that weed eradication is the principal, if not the only, beneficial result of cultivating this crop after planting. This means that in cultivating the corn crop the implements used should be designed primarily for accomplishing the destruction of weeds in the easiest and cheapest way. It seems to indicate, further, that as weed control becomes more thorough,

FIG. 105.—Orchard infested with hayfever weeds.

FIG. 106.—Suburban lot, a source of hayfever.

intercultural tillage of growing crops may be accordingly decreased.

"Some men do not attack weeds with enough vigor; they look for rocking-chair methods of work. There is no royal road to weed control. In the main, the old doctrine of 'hard work and plenty of it' must be observed, but unless this work is applied intelligently a vast amount of labor may be expended with but little accomplished other than a temporary abatement of the evil."

Fig. 105 shows an orchard crowded with hayfever weeds, which should have been kept in cultivation or sown in grass. Fig. 106 is a suburban lot where value has been depreciated by the rank growth of hayfever weeds.

CONTROL OF HAYFEVER WEEDS IN THE PACIFIC AND ROCKY MOUNTAIN STATES.

The prevention of hayfever by the control of weeds that produce the noxious pollen is a more complicated problem in the Pacific and Rocky Mountain states than in the eastern states. This is partly due to the fact that the hayfever in the former is caused by the pollen of a larger variety of plants.

In the early (vernal) form of hayfever which, in all the states, is due principally to the pollen of the grasses (*Gramineæ*), this presents no great difficulty. The potential area of the grass pollens is not great and the enforcement of suitable grass-weeds ordinances is sufficient to practically eliminate this, at least in towns and cities.

The fall hayfever, however, which in the Pacific and Rocky Mountain states, is due principally to the pollen of the wormwoods (*Artemisias*), marsh elders (*Ivas*) and false ragweeds (*Gærtnerias*), presents greater difficulty as regards control, both on account of the larger number of these plants and the greater buoyancy of their pollen.

The larger variety of plants, however, is partially offset by the far greater buoyancy of the common ragweed of the eastern states. Measuring only 15 microns in diameter and having a spiculated surface which adds almost 50 per cent to its buoyancy, the potential area of the common ragweed

pollen is so great that it will traverse several miles in a wind of 20 miles per hour, as demonstrated by our atmospheric-pollen plates.

The wormwoods (*Artemisias*), however, on account of the size of their pollen, which average about 24 microns, will traverse only one-sixth of the area of the common ragweed, this area being still more reduced by the fact that the surface of the wormwood pollens is smooth instead of spiculated as in the ragweeds. In spite of the great prevalence of these plants therefore, legislative measures for their eradication from the vicinity of municipalities should prove reasonably effective. This also applies to the western ragweed (*Ambrosia psilostachya*), whose pollen measures 25 microns, which also restricts its potential area.

The false ragweeds (*Gærtnerias*), however, which bear a resemblance to the ragweeds both in the spiculated pollen and in their hayfever reaction, also give a light buoyant pollen (average 17 microns), which give them an extended potential area. On this account, special efforts should be made to eliminate them from the neighborhood of communities.

CHAPTER XXI.

LEGISLATION IN THE PREVENTION OF HAYFEVER.

THE prevention of no disease of serious importance has received so little attention as that of hayfever. Although ranking as one of the most common of the non-fatal diseases, it is only recently that any organized efforts have been made for its prevention.

The records of the American Hayfever Prevention Association show that about 1 per cent of the population of the United States is subject to hayfever,[1] so that the number, about 1,000,000, is sufficient to demand the most earnest consideration.

The serious effect of hayfever is not well understood. From one to two months, and sometimes much longer, the victim of hayfever suffers from symptoms which depress his vitality and lower his energy. Asthma and bronchitis are complications in a large number of cases. In our hayfever clinic at the Charity Hospital, we have had cases of hernia from violent sneezing, also cases of mastoiditis, sinusitis and many other complications of minor importance. Marked nervous depression is common among hayfever sufferers as a result of the prolonged respiratory disturbances.

The etiological relation of pollen to hayfever and hayfever asthma is now as well established as the cause of malaria, diphtheria or typhoid fever. Its recognition, however, is an important factor in instituting practical methods for the prevention of hayfever. Education and legislation in the prevention of hayfever, as in other important sanitary measures, are closely allied. Without proper education in

[1] Scheppegrell: Hayfever, its relation to Seasons, Occupations, Sex and Color, New York Med. Jour., December 9, 1916.

the advantages and necessity of such measures, legislation is hard to enact and difficult to enforce. Without legislation, however, only partial benefit is obtained from education, as there are always many persons who will respect their neighbor's rights and health only to the extent enforced by the law.

In addition to the knowledge that hayfever is due to the inhalation of pollens, the public should have a general idea of the various kinds of hayfever. Briefly stated, about 90 per cent of the fall cases of hayfever in the eastern and southern states are due to the common and giant ragweeds (*Ambrosia elatior* and *trifida*), the remainder being due to the cockle bur (*Xanthium*), marsh elder (*Iva*), Russian thistle (*Salsola pestifer*) and a few other weeds, most of which are only of local importance. In the Pacific and Rocky Mountain states the ragweeds are replaced by the wormwoods (*Artemisias*). (See Chapter V, Hayfever Plants in the Pacific and Rocky Mountain States.)

The golden rod, roses and resin weed, associated with hayfever in the public mind, are not responsible. Not being wind-pollinated, their pollen is not found in the air, which is essential for the development of hayfever. This has been corroborated by our atmospheric-pollen plates, which are exposed during all seasons to detect the various pollens found in the atmosphere.

Vernal hayfever is due principally to the pollen of the grasses, in addition to that of the amaranths (*Amaranthus*), chenopods (*Chenopodium*) and yellow dock (*Rumex*). The pollens of the trees are responsible for hayfever only in certain localities.

STATE LEGISLATION.

The warfare against weeds, even from an agricultural standpoint, has been considered of so much importance that many states have enacted laws to control them. So difficult was the task of fighting these weeds individually, and so onerous from the standpoint of labor and expense, that the legislative power of the state was invoked to assist in their eradication.

In many cases this has been entirely successful, as the weeds against which this special legislation was directed have practically been controlled.

The most important hayfever weeds, however, such as the ragweeds, have not been specified in most of these laws, as their noxious character from a health standpoint has only recently been recognized; but many of the less active hayfever weeds are mentioned, such as the Russian thistle, yellow dock, cockle bur, etc. In New York, an antiweed bill has been introduced in the state legislature, which specifically mentions the ragweeds and other hayfever weeds.

The weed laws of the various states[1] divide themselves naturally into two types: (1) Legislation against growing weeds; and (2) legislation against weed seeds. All of the states have enacted weed laws with the exception of Delaware, Georgia, Louisiana, Maine, Maryland, Massachusetts, Mississippi, Nevada, New Hampshire, New Mexico, Rhode Island, Virginia and Wyoming. The other thirty-three states have laws on the subject which have been enacted anywhere from about the year 1860 to the present time.

The northeastern states were the first to enact laws, which applied to the cutting of weeds in the public highways and on railroad rights-of-way, and it may be said that the custom of cutting weeds in these situations is now quite generally enforced.

The northwestern states and also some of the southwestern states have passed weed laws rather stringent in character to control noxious weeds on private property as well as on the public highways. The enforcement of these laws is largely with the city or country authorities, but in a few instances the enforcement is put in the hands of the state board of agriculture or in the hands of a pest commission appointed by the state agricultural authorities.

These laws are, in a large measure, dead letters and are not actively enforced. Recently, however, Wisconsin passed a weed law which is being actively enforced.

The Canadian provinces are far ahead of the United States

[1] Report of Albert A. Hansen, Agronomist, U. S. Department of Agriculture.

in this matter. Nearly all of the laws throughout the country aim to control the spread of thistles, particularly the Canada thistle (*Circium arvense*). In the northwestern tier of states the laws are usually directed against such weeds as:

Thistles	
Burdock	*Arctium lappa*
Cockle burs[1]	*Xanthium* sp.
Mustards	
Docks[1]	*Rumex* sp.
Indian mallow	*Abutilon theophrasti*
Jimson weed	*Datura stramonium*
Quack grass[1]	*Agropyron repens*
Plantain[1]	*Plantago* sp.
Wild parsnip	*Pastinaca sativa*
Shoofly	*Hibiscus trionum*
Wild carrot	*Daucus carota*
Russian thistle[1]	*Salsola tragus*
Wild oats[1]	*Avena fatua*
Ox-eyed daisy	*Chrysanthemum leucanthemum*
St. John's wort	*Hypericum perforatum*
Poverty weed[1]	*Iva axillaris*
Prickly lettuce	*Lactuca scariola*
Wild sunflower	*Helianthus annuus*
Barberry	*Berberis vulgaris*
Toad flax	*Linaria vulgaris*
Wild barley	*Hordeum jubatum*

In the southwestern states the legislation is in most instances directed primarily against Johnson grass (*Sorghum halepense*), though some of the weeds above mentioned are included in some of these states.

It will be noted that the principal hayfever weeds, such as the ragweeds and the artemisias, are not included in this list.

The following is a list of the states having antiweed laws and the weeds which form the object of this legislation:

LAWS OF THE VARIOUS STATES FOR THE CONTROL OF WEEDS.

Connecticut.—Statutes providing for the destruction of Canada thistle, burdock, white or ox-eyed daisy, snapdragon or toadflax, sow thistle, yellow dock, mustard, wild parsnip and quack grass.

[1] Sources of hayfever.

Idaho.—Act enabling 25 per cent of resident freeholders of any road district to petition board of county commissioners for the destruction of any noxious weeds.

Illinois.—Destruction of cockle bur, Canada thistle, Russian thistle and all other kinds of thistle.

Michigan.—Destruction of Canada thistles, milkweed, wild carrots, ox-eyed daisy or other noxious weeds.

Missouri.—Destruction of Canada or Scotch thistles.

North Dakota.—Destruction of noxious weeds.

Ohio.—Destruction of all brush, briers, burs, vines, Russian or Canadian or common highway thistles growing along the public roads.

Oregon.—Destruction of Russian thistle, Canada thistle, Chinese thistle, cockle bur (*Atriplex argentia*) (called silver salt bush).

Pennsylvania.—Destruction of Canadian weeds or thistles.

The following states also have antiweed laws: Alabama, Arizona, California, Kentucky, South Carolina and Washington.

While such laws, properly enforced, will be of valuable assistance, permanent relief will require uniform legislation by the various states. In the states in which weed laws already exist, as in Connecticut, Idaho, Illinois, Michigan, North and South Dakota, Oregon, Ohio, Pennsylvania, etc., the amendment of these statutes to include the ragweeds and other hayfever weeds should present no great difficulty. In the remaining states the introduction of suitable legislation will be facilitated by the education of the public in the need of such laws not only from an agricultural but also from a sanitary and economic standpoint.

The practical solution of the hayfever problem, however, is within the power of the Federal Government. Should it be declared a violation of the Interstate Law to transport seeds of ragweeds and other hayfever weeds from one state to another, the farmer in self-defense would be compelled to destroy these weeds on his farm. This would not only result in an enormous reduction of hayfever weeds, but would also be of great benefit to the farmer, as the United States Department of Agriculture has repeatedly shown that millions of dollars are lost annually from the neglect of weeds.

While such plans may at first sight appear radical, similar ones are already in force for the protection of our agricultural interests. The transportation of diseased plants and trees into certain states is punishable with severe penalties, and there has been no great opposition to their enforcement.

When we realize the great amount of suffering that may be prevented by these means, which at the same time tend to improve the efficiency of our agricultural methods, the enactment of such laws should be strongly urged by all those interested in relieving mankind from the oppression of this distressing disease.

Health is one of man's most valuable assets, and every person has a right to demand that his health shall not suffer on account of neglect on the part of his neighbor. If hayfever weeds are allowed to grow on neglected premises, vacant lots and uncultivated fields, and to infect the air with noxious pollen, the sufferers are evidently entitled to relief. A thorough education of the public regarding the noxiousness of hayfever weeds, reinforced by adequate legislation, should soon result in removing hayfever from the list of common diseases.

South Dakota.—Destruction of wild sunflower, Canada thistle, cockle bur, burdock and quack grass.

MUNICIPAL LEGISLATION.

In view of the great suffering caused by hayfever, and the possibility of its prevention by the eradication of hayfever weeds, the control of these in cities should form an important feature in public health measures. For this purpose, suitable ordinances, such as are already in force in a number of cities, are practicable, and their enforcement will soon show a corresponding reduction in the number of hayfever cases, especially of the vernal type.

In New Orleans, where, through the efforts of the American Hayfever Prevention Association, such an ordinance was passed by the Commission Council on January 15, 1916, the enforcement of such measures resulted in a marked reduction of the spring form of hayfever. The records of the

association, corroborated by the president of the city board of health, showed that this decrease was not less than 50 per cent, as well as an amelioration of the symptoms of those who suffered from the attacks.

It is important, however, in preparing such an ordinance, that the requirements should not be too drastic. In a prominent city, for instance, there is at present an ordinance requiring the grass to be kept below four inches, the results of which is continued legal opposition to its enforcement. We advise a limit of twelve inches, for weeds, which is sufficient to prevent the pollination of most hayfever weeds, and is easily enforced. Nor should the penalty be so high as to encourage litigation. We have found a penalty of one dollar for the first offense, and increasing penalties afterward, give good results.

While the New Orleans weed ordinance of 1916 was of much benefit, it had the objection that if the owner of the property, containing the offending weeds, refused to cut them, he could only be fined, which still left the pollen to infest the neighborhood. To correct this, the American Hayfever Prevention Association introduced a suitable law in the state legislature of 1918, which was passed without opposition, authorizing the city of New Orleans to pass an ordinance by which, in the event that the weeds were not cut, that the city, after due notice, could have them cut, and the cost charged with the taxes against the owner of the property. This was duly enacted by the city of New Orleans on October 2, 1918, and is now in force.

As the ordinance is quite effective for the control of hayfever weeds, it is recommended as an effective measure against hayfever weeds from both a sanitary and civic standpoint. The following is a copy:

Form of Grass-Weeds Ordinance.

An ordinance for the better protection of the public health, and particularly to prevent the spread of disease by providing for the cutting, destruction or removal of noxious weeds or grass, or deleterious, unhealthful or noxious growths,

on any sidewalk or banquette or on any lot or place or area within the city of New Orleans.

SECTION 1. Be it ordained by the Commission Council of the city of New Orleans, that no person, firm, association or corporation, the tenant or occupant of any leased or occupied lot or place or area, shall permit any noxious weeds or grass, or deleterious, unhealthful or noxious growths, over two feet in height, to grow or stand on any lot or place or area leased or occupied by said person, firm, association or corporation, or on any sidewalk or banquette abutting any lot or place or area leased or occupied by said person, firm, association or corporation.

SECTION 2. Be it further ordained, etc., that no person, firm, association or corporation, the owner of any lot or place or area not leased or occupied by another person, firm, association or corporation, shall permit any noxious weeds or grass, or deleterious, unhealthful or noxious growths, over two feet in height, to grow or stand on any lot or place or area owned by said person, firm, association or corporation, or on any sidewalk or banquette abutting any lot or place or area owned by said person, firm, association or corporation.

SECTION 3. Be it further ordained, etc., that for the purpose of enforcing the provisions of this ordinance, a corporation shall be deemed to be represented by its president, or in his absence by its vice-president, or in the absence of both by the officer or individual in charge of the affairs of the corporation, and such representative shall be held responsible and punished for any violation by the corporation of the provisions of this ordinance.

SECTION 4. Be it further ordained, etc., that each of the members of a firm shall be held responsible and punishable for any violation by the firm of the provisions of this ordinance.

SECTION 5. For every violation of any of the provisions of this ordinance, the person responsible shall, on conviction, be punished by a fine of not less than one dollar, nor more than twenty-five dollars, and in default of payment of the fine, by imprisonment in the parish prison for not less than

ten days, not more than thirty days, or both, in the discretion of the court having jurisdiction.

SECTION 6. Be it further ordained, etc., that in addition to the provisions hereinbefore made for the cutting, destruction or removal of weeds, grass and growths, and notwithstanding the penalties provided for in Section 5 of this ordinance, the Commissioner of Public Property is hereby authorized to cut, destroy or remove any noxious weeds or grass, or deleterious, unhealthful or noxious growths, over two feet in height, growing or standing on any sidewalk or banquette, or on any lot or place or area, within the city of New Orleans; provided no such work shall be undertaken by said Commissioner until the owner of the lot or place or area where such weeds, grass or growths are to be cut, destroyed or removed, or the owner of the property abutting the sidewalk or banquette where such weeds, grass or growths are to be cut, destroyed or removed, as the case may be, shall have had an opportunity of doing the work himself within at least ten days after previous notice has been given him, or in his absence from the city, to the agent of leased or occupied premises, or if not known to the occupants thereof, or if not leased or occupied, by advertisement in the official journal of the city of New Orleans for two consecutive days.

The charge, cost and expense of such work is, to the extent of the actual cost thereof to the city, by Act No. 136 of the General Assembly of the state of Louisiana, Session of 1918, declared to be a charge, cost or expense of the property abutting the sidewalk or banquette or of the lot or place or area, as the case may be, where such noxious weeds, grass or deleterious or unhealthy growths may be cut, destroyed or removed; and the Commissioner of Public Property shall demand of the owners of such property the payment of such charges, costs or expenses.

If after the cutting, destruction or removal of such weeds, grass or growths as aforesaid shall have been done by the Commissioner of Public Property after due notice as above stated, the cost or expense thereof shall not have been paid within ten (10) days after due demand, then and in that

case the Commissioner of Public Property shall cause to be recorded in the mortgage office of the parish of Orleans an attested bill showing the cost and expense incurred for the work and the place or property on which said work was done, so as to establish for the city the lien and privilege securing payment by the property owner of said charges, costs and expenses, accorded by said Act No. 136 of 1918.

Adopted by the Commission Council of the city of New Orleans, October 1, 1918.

COUNTRY MEASURES.

The importance of having the country assist the cities in the work of hayfever eradication should be well understood. As long as the winds are below 5 miles per hour, the pollen of the common ragweed, for instance, is borne but a short distance and the cutting of neighboring weeds is quite effective. When, however, the wind velocity reaches 15 or more miles per hour, the pollen is, for the time being, carried several miles, and, in this way municipalities may be infected from the surrounding country.

CHAPTER XXII.

HAYFEVER RESORTS.

As it has been definitely established that hayfever is due to the inhalation of pollen, it would appear to be simply a question of eliminating all wind-pollinated plants from certain areas in order to be free of this disease. This has been actually demonstrated in a number of places, which have in this way acquired considerable popularity as hayfever resorts. All weeds and grasses are scrupulously cut, not only through the influence of city ordinances, which are strictly enforced, but through the influence of public opinion, as the visitors are a source of profitable revenue. The relative freedom of hayfever in these places is due to the fact that, in addition to the natural low rate of atmospheric-pollen, all weeds with wind-borne pollens[1] are rigidly excluded.

The history of hayfever resorts, before pollen was discovered to be the cause, forms an interesting example of the unreliability of health measures when not based on scientific principles. A sufferer from hayfever, in his efforts to find a place in which he will have relief, reaches a location many miles from human habitations and cultivated fields, perhaps in a virgin forest, and his attacks disappear. He pitches his tent, passes his time in fishing and hunting, and returns home convinced that he has at last found the mecca of hayfever sufferers. The place is advertised, cottages are built and perhaps even a hotel, and the first year the reputation is sustained—no one has hayfever.

The next year the plans are extended. The timber is cut and the land is planted in corn and oats for the stock, and vegetables for the guests. Immediately the seeds of

[1] Attractive flowers of all kinds, whether wild or cultivated, are practically all insect-pollinated, and, as the pollen is not in the air, they do not cause hayfever, although some may cause a reaction on direct inhalation.

the weeds, the parasites of agriculture are brought in by the stock, the hay, oats and seeds, and the weeds appear with their millions of noxious wind-borne pollen.

The guests now begin to suspect that the location is not entirely free of hayfever. The following year the weeds have increased in number and activity, and the pollen abounds in the air. Hayfever is common, the guests leave in disgust, and the place is abandoned. This history of the rise and fall of hayfever resorts has repeated itself in almost every part of the country.

The recently established resorts, however, being scientifically based on the exclusion of all weeds, have maintained their reputation, and increased in popularity. It is only a question of time, however, when every summer resort will be compelled, in its own interest, to take similar steps for the comfort of hayfever sufferers. The elimination of hayfever in towns and cities generally is simply a question of time, this result depending upon the thoroughness with which the weeds are destroyed.[1]

It is popularly believed that hayfever is gradually increasing in prevalence, and this is supported by the statistics which we have collected from all parts of the country. The cause, however, is not the increase of susceptibility as is usually supposed, but of greater exposure. It is well known that hayfever is less frequent in the heart of crowded cities, and many living in the suburbs find relief at their places of business. The reason is that these congested parts of the cities are beyond the potential radius of the hayfever weeds and grasses of the suburbs and surrounding country.[2]

The true reason is, therefore, that the ease of transportation has enabled thousands of people to live in the suburbs and surrounding country of all large cities. Most of these localities are sparsely settled, and are surrounded by vacant lots and fields. The latter too frequently are abandoned to ragweeds and other hayfever plants, even in cases in which a crop has been cultivated at some portion of the year. The

[1] Scheppegrell: The Prevention of Hayfever as a National Problem, Jour. of Am. Pub. Health Assn., 1918.

[2] Scheppegrell: Hayfever and Hayfever Pollens, Arch. Int. Med., June, 1917.

air in these places is, therefore, infested with hayfever pollens, which find their victims in subjects with low immunity to their protein.

There are a number of places in the United States and Canada in which the meteorological or topographical condition prevents the growth of the plants that cause hayfever, and which may therefore be termed natural hayfever resorts. There are various forms of hayfever, however, and, accordingly, there are localities in which one class of hayfever sufferers find relief, but in which others are not benefited. A patient from Illinois, sensitive to the common ragweed (*Ambrosia elatior*) hayfever only, would find relief in California, where this is not found, but a subject in California, sensitive to the sagebrush (*Artemisia*) only, would be relieved in Illinois, where this weed is not found. This explains the apparent contradiction in regard to many popular hayfever resorts.

There are some localities, however, in which the natural flora of all hayfever weeds is extremely low, so that they offer relief to the great majority of hayfever cases of all forms.

For several years the American Hayfever Prevention Association has been endeavoring to form a reliable list of such localities, so that physicians might be able to direct their hayfever patients to the nearest resort in their vicinity. In this work we have received valuable assistance from most of the state boards of health, from physicians in general, and from our botanical department.

PARTIAL RELIEF.

Contrary to the popular belief, altitude is no protection against hayfever unless this exceeds 6000 feet. Up to 4000 feet, the common ragweed (*Ambrosia elatior*) is as common as on the plains. At an altitude over 6000 feet, however, the ragweed does not thrive, and such localities afford relief to those sensitive to this pollen. Some of the wormwoods (*Artemisia frigida*), however, are found at this altitude, but these are practically confined to the Pacific and Rocky Mountain states.

An island that is kept free of weeds, and has no land nearer than 10 miles, is practically free of hayfever pollen, and is therefore without hayfever. Even 1 or 2 miles is ordinarily a sufficient water protection, as the lightest pollen of the hayfever weeds (ragweeds, 15 microns in diameter) does not traverse more than this distance except in winds of high velocities (15 or more miles per hour).

The apparently erratic benefits of coast resorts to hayfever sufferers is simply a question of wind direction. If this is from the water, the air is free of pollen, and hayfever subjects find relief. If the wind is from the land, however, and this is infected with hayfever weeds, which is usually the case, the proximity of the water affords no protection.

COMPLETE TEMPORARY RELIEF.

There are a number of places in the United States and Canada, where, on account of the altitude (over 6000 feet), latitude or the presence of extensive forests, the common hayfever weeds are not found, and which are therefore relatively free of hayfever. The following list of such places has been carefully compiled, and should prove convenient to practitioners in general, who are frequently at a loss as to the nearest hayfever resort for their patients.

HAYFEVER RESORTS IN THE UNITED STATES.

Arkansas.—Eureka Springs, Heber Springs, Sylvan Springs and Winslow, all located in the Ozark Range.

California.—Santa Cruz, Del Monte, Santa Barbara and Coronado along the coast, and Lake Tahoe and other places among the high Sierras.

Colorado.—Silver Plume, and other mountains with an altitude over 7000 feet.

Connecticut.—The Litchfield Hills, in the northwestern part of the state, afford relief in a certain class of cases along the coast, and the seaside resorts, especially in the New London district, afford relief to a class of inland cases.

Florida.—The coast of southern Florida affords partial relief.

Georgia.—Brasstown, Bald Mountain.

Louisiana.—Covington and Abita Springs afford relief in the vernal type of hayfever.

Maine.—Rangeley Lakes and Kineo, located on Moosehead Lake.

Michigan.—At Mackinac Island, in a series of 100 cases, 32 patients were free of hayfever, 50 were improved, and 18 were not benefited.

Minnesota.—Duluth is favorably reported.

Mississippi.—Pass·Christian, Bay St. Louis and other coast resorts afford relief in the vernal form of hayfever.

Nebraska.—The high elevated area of the western part of the state.

New Hampshire.—Bethlehem, located in the White Mountains, has long been a favorite resort for hayfever sufferers; Bretton Woods, Jefferson Fabyans and Dixville Notch are other resorts.

New Jersey.—Partial relief at location along the Atlantic coast and Beach Haven in Ocean County.

New Mexico.—Cloudcroft, Whitcom Springs, Albuquerque, Valley Ranche, Glorietta, Jemez Springs, Sulphur Springs, El Porvenir and East Las Vegas.

New York.—The Adirondacks (highest point, 5379 feet), Fire Island (an insular strip of land south of Long Island), Thousand Islands Park, Big Moose and Old Forge Lake.

North Carolina.—Eagle's Nest (altitude, 5050 feet), Glen Ayre, Blackstock Knob (6378 feet), Black Dome (6502 feet), Mount Gibbs (6591), Hall Back (6403 feet) and Mount Mitchell (6711 feet) in the Black Mountains; Double Spring (6380 feet), Richland Balsam (6370 feet) and Jones's Knob (6224 feet) in the Balsam Range, and Mount Buckley (6599 feet), Clingman's Drive (6660 feet), Mount Love (6443 feet) and Alexander (6447 feet) in the Smoky Mountains.

North Dakota.—Devils Lake.

Pennsylvania.—Eaglesmere, the Pocono Mountains, the hills in the vicinity of Bradford, and the mountains near Mount Alto and Caledonia.

South Carolina.—Cæsar's Head, Greenville County.

South Dakota.—Hot Springs.

Tennessee.—Roan Mountain (altitude, 6310 feet) has long been noted for its relief to hayfever sufferers.

Texas.—San Antonio is reported as having but few hayfever cases.

Utah.—There are a number of places in various parts of this state, having an altitude of over 6000 feet, which afford relief to hayfever subjects; also several canyon resorts, such as Brighton and Ogden, where comparative immunity exists. Many persons from Salt Lake City, which has an elevation of 4300 feet, visit these places with relief.

Vermont.—Green Mountains (highest point, 4430 feet).

Washington.—Although there is the usual percentage of hayfever east of the Cascade Mountain Range, there is practically none in any part of the state west of this range, which is therefore favorable to hayfever subjects.

West Virginia.—Terra Alta, Marlinton and Webster Springs are favorably reported, although their altitude (2500 feet) is not sufficient for marked benefit.

Wisconsin.—Two Rivers, located on a peninsula extending seven miles into Lake Michigan, is favorably reported.

CANADIAN HAYFEVER RESORTS.

Province of Alberta.—This province is remarkably free of hayfever, many persons from the United States and eastern Canada obtaining marked relief.

Province of Ontario.—The Muskoka Lake region and the National Park, known as Algonquin Park, abounding in lakes and densely wooded, have a low percentage of atmospheric-pollen. Campobello, in the Bay of Fundy, and Prince Edward Island, in the Gulf of St. Lawrence, are favorably reported.

EUROPE.

The ragweeds and other members of the *Ambrosia* family are not found in Europe, so that it offers immunity to our common fall hayfever. The grasses (*Gramineæ*), however, are common, so that the vernal type of hayfever is fairly prevalent in many sections.

CHAPTER XXIII.

THE TREATMENT OF HAYFEVER.

HYGIENIC MEASURES.

HYGIENIC measures are as important in the control of hayfever as they are in typhoid fever, malaria, yellow fever and other preventable diseases. By living in a weed-infested neighborhood a patient greatly increases the difficulties of his immunization and frequently necessitates the raising of his immunity to 85 per cent, when ordinarily 70 per cent would be sufficient. In all cases treated at the hayfever clinic at the Charity Hospital, patients are given charts of nine blocks of their neighborhood, with instructions to locate thereon lots that are infested with weeds. When this has been done, the charts are sent to the city board of health, which notifies the owners of the lots to cut the weeds, under penalty of prosecution for violating the grass-weeds ordinance.

In order to demonstrate the efficiency of such measures, the American Hayfever Prevention Association, in 1916, employed special inspectors to coöperate with the regular force of the New Orleans Board of Health, with the result that the number of spring hayfever cases of that year was reduced to less than 50 per cent. As the fall hayfever in Louisiana is due to the ragweeds (*Ambrosias*), whose potential radius is ten times greater than that of the grasses which cause the spring hayfever, the benefit in the fall cases was much less marked, as the pollen blew in from the surrounding country.

In the selection of homes, hayfever subjects should choose localities distant from weed-infested areas. The pollen of the grasses, and of the summer hayfever weeds generally, does not ordinarily travel very far, and a mile

is usually a safe distance. The pollen of the ragweeds and other fall hayfever weeds, however, is very buoyant, and in windy weather may travel 3 to 5 miles.

During their attacks of hayfever patients should avoid localities infested with weeds generally, and especially with those weeds to whose pollen they are sensitive. Should their neighborhood be infested with weeds, and a grass-weeds ordinance be in force, this condition should, in the interest of public health, be reported to the board of health.

During the hayfever season patients should avoid driving or riding into suburbs abounding in weeds. An attack resulting from this increased exposure may lower their resistance and make them more susceptible to the pollen of their own neighborhood.

A reasonable amount of exercise is beneficial; but this should be taken without increased exposure to the hayfever pollens. Swimming, especially in salt water, is an excellent form of exercise.

Considerable literature is published each year in the lay press regarding the benefit of the "cold storage" treatment of hayfever. As practically all ventilation is excluded in this treatment, there is an absence of atmospheric-pollen, which is the principal cause of the relief which the patients experience. The low temperature, however, instead of being a benefit, is really a source of danger, as we have had several cases of bronchitis which resulted from such exposure. In any event, the relief is only transient and can be as well obtained in any room from which the pollen-laden air is excluded.

SCREENING, MASKS AND INHALERS.

When a hayfever subject has been operated on or is seriously ill from other causes so that the irritation of sneezing and other symptoms of hayfever would not only be annoying but even dangerous, the patient may be protected by having the windows of his room screened with a thin cloth saturated with water. All pollen coming in contact with the

moist cloth would not only be arrested but robbed by its toxicity.[1]

When this method of screening is not practicable, a special inhaling mask, based on the same principle and serving the same purpose, may be arranged for the patient.

There are on the market a number of widely advertised inhalers for the prevention of hayfever. The device is inserted into the nostrils, and a fine gauze is supposed to filter the inhaled air free from hayfever pollens. Aside from the question as to whether a mesh with openings of 0.005 cm. prevents the entrance of pollens 0.0015 cm. in diameter, we were unable to find a patient who did not prefer the hayfever to the discomfort of wearing the inhaler.

DIET.

The diet of hayfever subjects during the hayfever season should be light as regards food rich in protein, such as meat, fish, eggs, cheese and milk. Farinaceous food may be taken in moderation. Vegetables are of benefit, as is also fruit.

High seasoning should especially be avoided, as it frequently reacts on the membranes of the nostrils already irritated by the pollen. Alcoholic drinks are injurious.

In cases complicated by asthma, the rules regarding diet should be carefully observed, and it is preferable in these cases to have the principal meal during the middle of the day.

There are certain articles of food that should be avoided in special cases; but these vary within such wide limits that no specific rules can be formulated. In one case, for instance, an attack of hayfever could be aggravated by a piece of watermelon, in another by peaches. Mustard and pepper should be avoided, and occasionally, also, tea and coffee.

SURGICAL METHODS.

While abnormal nasal conditions in their relationship to hayfever have been given undue importance by some rhin-

[1] Toxicity here refers to the positive reaction in hayfever subjects.

ologists, they should, nevertheless, be given careful consideration as forming a predisposing factor in hayfever. In fact, any condition which tends to develop a hypersensitiveness of the nasal mucosa predisposes the patient to an incipient sensitization which tends to result in a persistent form of hayfever.

Marked septal spurs, ridges or deflections, which cause a concentration of pollen in the obstructed nostril, or which touch the opposite turbinal and thus cause irritation, congestion and hypersensitiveness, may form an important predisposing cause. Infection of the sinuses, especially of the ethmoidal cells, should receive careful attention.

While the percentage of cures from operations on these cases is not high (7 per cent), they should not be overlooked in the prophylaxis of hayfever.

Nasal surgery in hayfever, however, should be avoided except in such conditions as indicated above. In other cases operations are unnecessary inflictions on the patient and are without benefit. One of our patients, a physician, had both inferior turbinates cauterized and then removed and the right ethmoidal cells eviscerated without benefit, and the surgeon had advised a similar operation on the left side. Another patient had nine operations performed, including several electrocauterizations, without perceptible benefit to his hayfever. These cases indicate not only the futility of excessive surgery, but also the distressing character of a disease that would make the patient submit to these repeated ordeals.

In hayfever the electrocautery has probably been used more frequently than any other surgical method. It is based on the idea that in hayfever there is an intumescence of the inferior turbinals which the cicatricial contraction following the cauterization is intended to relieve.

There are few cases, however, that have been benefited by this method, and we have seen many patients who claim that their condition was aggravated by the cauterization. In view of these facts electrocauterization should be avoided in hayfever.

In a series of 1000 cases (Series C. D and E) treated in the hayfever clinic of the Charity Hospital and in private practice, 8 per cent had been operated on for hayfever without apparent benefit.

CONSTITUTIONAL TREATMENT.

Calcium chloride or, preferably, the less irritating calcium lactate, is occasionally of benefit in hayfever. It should be given after meals in doses of 15 grains, well diluted.

In cases of hyperacidity, sodium bicarbonate in the effervescent form should be administered. The dose is 15 grains, three or four times daily. In one of our cases a seasonal cure resulted from the administration of 10 grains of quinine three times daily; in other cases it was without benefit. It is indicated that in this case malaria was the predisposing cause, which was corrected by the quinine.

In cases associated with asthma, sodium iodide may be administered, preferably 10 to 20 drops of a saturated solution, three times daily, and well diluted.

Mercury has also been used in hayfever, and Barton L. Wright, of the United States Navy, reports several cases successfully treated. He prefers the succinimide of mercury, $\frac{1}{5}$ grain in distilled water, this being injected deeply into the gluteal muscles. He believes that the effects are due to the fact that patients, after a mercuric treatment, have a peculiar power of resistance of infection of every kind.

LOCAL TREATMENT.

Menthol, in the form of an oily spray, is of benefit in some cases of hayfever, but aggravates the attack in others. Two grains to the ounce of liquid petrolatum is the usual proportion. The following formula gives temporary relief, but tends to establish the cocaine habit:

℞—Epinephrin sol. 1-1000 . . . . f℥j
2 per cent sol. cocaine,
Normal saline solution . . . . āā f℥j
Sig.—Two drops into each nostril as directed.

Solutions of cocaine and of epinephrin tend to develop a reactive turgescence of the nasal mucosa which aggravates the hayfever. They should, therefore, be used only to give relief in severe paroxysms.

The epinephrin and cocaine may also be used in the form of an ointment, but this should be prescribed with the same precautions as the solution.

For the conjunctivitis that frequently accompanies hayfever, 5 per cent argyrol may be used, or the following may be prescribed:

℞—Sodii biboratis,		
Acidi borici	āā	gr. xv
Sodii chloridi		gr. iij
Aquæ dest.	q.s.	f ℥j

Sig.—For eyes as directed.

NASAL MASSAGE.

As a means of reducing the hypersensitiveness of the nostrils before the opening of the hayfever season, and for correcting the intumescence of the nasal mucosa which frequently remains after the paroxysms have subsided, we use a form of nasal vibratory massage. For this purpose, a mechanical vibrator is used which we first devised in 1908 (Fig. 107). It is operated by compressed air under a pressure of fifty to sixty pounds. The air drives the piston forward and backward in the cylinder, and this imparts a vibratory movement to the nasal applicator. The arrangement is such that the operation of the applicator in the nasal cavity can be observed. Cotton is attached to the end of the applicator, and a 4 per cent solution of iodized phenol in glycerin is applied to the cotton.

By means of this instrument, a vibratory massage is applied over the inferior turbinate, septum and the lower portion of the middle turbinal. At first the massage is made very lightly and only for a short time, but the action is gradually increased as is also the length of time of application. The massage is usually applied two or three times weekly.

Vibratory massage is a useful supplementary treatment, and, in a small percentage of cases, has resulted in a cure

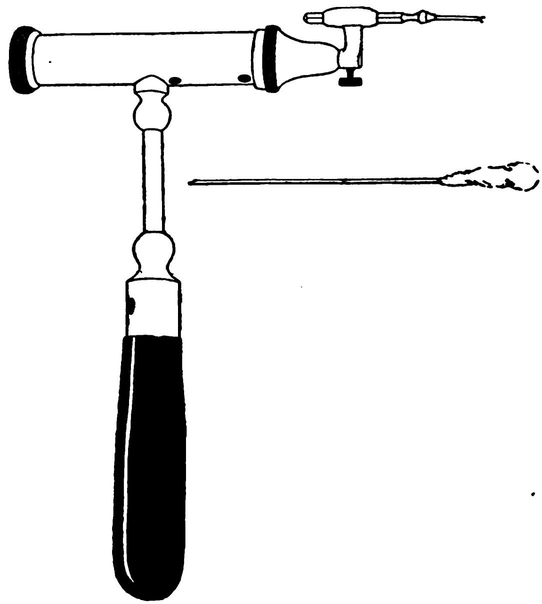

FIG. 107.—Author's instrument for vibratory massage in hayfever.

without other methods. It should be discontinued during the hayfever season, when the mucous membrane is irritated by the atmospheric-pollens.

CHAPTER XXIV.

IMMUNIZATION.

THE first systematic effort to treat hayfever by immunological methods was by Dunbar, in 1903. He isolated a substance, which he believed to be a "toxin," from the pollens and prepared an antitoxin, which he called "pollantin," by the injection of horses and rabbits. He claimed that the blood serum of these animals, after a prolonged treatment, had the effect of neutralizing the effects of the pollen. The pollantin is applied to the nasal mucosa or conjunctiva of hayfever subjects, preferably before the beginning of the attack.

Although reports of the successful use of pollantin were published, for some time after its introduction, many unfavorable reports have since been made. It is toxic to hayfever subjects when injected hypodermically, and Weichardt has demonstrated that it possesses no more therapeutic effect than the serum from which it is prepared. It is no longer used to any extent.

Koessler[1] also claimed the sensitization of guinea-pigs by the method of passive transfer. He states that he injected the serum of two hayfever patients into guinea-pigs in a dose of 4 cc. On the following day, he reinjected the animals, all of whom "showed severe typical symptoms of anaphylactic shock." In a carefully conducted series of experiments, however, Cooke, Flood and Coca[2] demonstrated that in no instance were the injections into guinea-pigs of the plasma of hayfever subjects followed by any toxic symptoms.

They believe that the failure of the passive transfer of pollen hypersensitiveness from hayfever subjects to guinea-

[1] Forcheimer's Therapeusis, 1914.
[2] Jour. Immunol., February, 1917.

pigs is due to the proved insusceptibility of the guinea-pigs to sensitization with pollen substances, or to the absence of antibodies to those substances in the blood of the hayfever patients.

ACTIVE IMMUNIZATION.

The first recorded efforts of active immunization was by Curtis[1] in 1900 and by Ingals[2] in 1903. In 1908 the author[3] succeeded in immunizing patients against fall hayfever by the inhalation of ragweed pollen into the nostrils. The objection to this method was that each inhalation was followed by a short paroxysm of hayfever, so that later the hypodermic injection of the pollen extracts was substituted.

In 1911 Noon[4] and Freeman[5] introduced the standardization of the pollen extracts, basing the doses upon the amount required to produce the ophthalmic reaction. This has simplified the application of this method.

The pollen extracts used for active immunization may be obtained from several of the larger biological laboratories. Their preparation is described by Hitchens[6] as follows: "To obtain the pollen, the flowers are gathered just when pollination has started. The flowers are dried and the pollen is collected by fine sieves. The pollen is preserved in the dry state until it is to be extracted.

1. The pollen is mixed with sufficient distilled water to make a fairly thick paste.
2. The paste is transferred to a porcelain ball mill and ground for twenty-four hours, or until a microscopic examination shows that the pollen grains are broken.
3. More distilled water is added and the mixture is centrifuged to remove insoluble debris.
4. The extracted protein is purified by precipitation with acetone.
5. The precipitate is dissolved in physiological saline solution. The amount of protein nitrogen in this solution is determined by the Kjeldahl method.

[1] Med. News, 1900.
[2] Jour. Am. Med. Assn., 1903.
[3] Scheppegrell: New York Med. Jour., December 4, 1909.
[4] Lancet, 1911.
[5] Ibid.
[6] New York Med. Jour., October 7, 1916.

6. The solution is then diluted so that each cubic centimeter contains fractions of 1 mgm. of protein nitrogen.

7. The final solutions are preserved from contamination by the addition of 0.3 per cent tricresol and sterilized by filtration. Sterility is determined by careful aërobic and anaërobic cultural tests.

The accepted unit of pollen therapy contains 0.001 mg. of pollen protein, this being the minimum dose required for children. The extracts should be dispensed in ampoules, and prepared so that the required number of units per cubic centimeter may be injected. Ampoules should contain 5, 10 or 20 c c, the strength being 10 to 1000 units to the cubic centimeter.

POLLEN THERAPY.

In all cases in which pollen extracts are used, the diagnostic tests should be applied in order to determine the character and degree of the hayfever reaction. This test consists in injecting into (not under) the skin of the forearm 5 units of the pollen extracts to be tested. These are determined by the pollenometric records, the principal pollens during the spring being from the grasses and, in the eastern, northern and southern states, from the ragweeds in the fall. The nasal, ophthalmic or cutaneous test may also be applied in special cases. (See Chapter VII on Symptoms, Diagnostic Tests and Susceptibility.)

For the convenience of our clinical records, the result of the intradermal tests is recorded on a percentage basis. A marked wheal, 2 or more c c in diameter, is recorded as 100 per cent, 1 c c 50 per cent., etc. While this is an arbitrary scale, it is valuable for purposes of comparison, and is much more definite than such terms as "mild," "marked," "severe," etc.

After the character and degree of the sensitization has been determined, the immunizing treatment is commenced by injecting 10 units of the extract of the pollen to which the patient is sensitive, and to which he will be exposed. If he is sensitive, for instance, to the grass pollens, which are

prevalent in the spring and early summer, this pollen extract is used for the spring injections.

If the patient is sensitive to both grass and ragweed pollens, the immunizing treatment for the grass pollens is commenced six to eight weeks before the grass season opens, and for the ragweed pollens, the same length of time before the commencement of the ragweed season. We do not consider it practicable to use the combined pollens in these cases, on account of the great difference in the seasons of exposure, and the variation in the degree of sensitivity to these pollens.

The pollen extracts for the immunizing treatment are usually injected two or three times weekly, and gradually increased until they reach 200 to 500 units. Very large doses are not often advisable, because our injections of medium doses have given better results, and also because excessive doses may produce severe reactions, not only of hayfever and asthma, but also of eczema, urticaria and angioneurotic edema.

As soon as the pollen to which the patient is sensitive appears in the atmosphere, as shown by the pollenometric records, the injections should be reduced to one-half the maximum number of units, as the patient is now absorbing the proteins from these pollens.

POLLEN AND VACCINE THERAPY.

While our experience has shown that pollen therapy is useful in the treatment of hayfever, we find that there are cases in which this form of treatment alone does not give satisfactory results, especially during the active stage of the disease. In such cases, therefore, pollen therapy is combined with vaccine therapy. The selection of the form of treatment usually varies with the patient's condition, this being influenced by the number of pollens which he is inhaling.

This number depends upon the season and the velocity of the prevailing wind. During the early part of the season, when the grasses and weeds are beginning to pollinate, and toward its end when this is nearly completed, the number

of pollens in the air is relatively small, and the patient's attacks are light. During the middle of the season, however, the number is greatly increased with corresponding discomfort to the patient.

The principal cause of the increase in the hayfever paroxysms is due to atmospheric disturbances during the active pollinating season. During a light wind, 1 to 6 miles per hour, pollen is carried only short distances; while in high winds, 15 to 25 miles per hour, pollen in large quantities is carried to great distances (5 miles or more), so that the number may reach 300 to 400 pollens per cubic yard of air. During the prevalence of such winds, all hayfever patients in the vicinity, who are sensitive to these pollens, suffer greatly.

If the patient applies for treatment during an attack of hayfever, the pollen extracts are usually ineffective, and a vaccine should be used, these being injected at intervals of one or two days until the severity of the attack subsides. The pollen extract is then used, the vaccine injections being resumed if a severe paroxysm develops.

Our reason for using the vaccine during severe paroxysms is that at this time the patient is suffering, not only from the effects of the pollen protein, but also from the great increase in the pathogenic microörganisms resulting from the lowered resistance of the respiratory membranes. The use of vaccine therapy at this stage is therefore logical, and has given us satisfactory results. In a few cases (3 per cent of a series of 1000 cases) the treatment of the successful ones was limited to vaccine therapy only.

The question of autogenous and stock vaccines has been carefully considered in our cases. The autogenous vaccines are preferable, provided they can be obtained of the proper standard and purity. When there is any doubt regarding this, the stock vaccines of unquestioned reliability should be given the preference.

We use three forms of stock vaccines, each containing 1000 millions to the cubic centimeter in various proportions of the following microörganisms: B. Friedländer, M. catarrhalis, pneumococcus, Streptococcus pyogenes, Staphyo-

coccus aureus and albus. As soon as the acute attack has subsided, the extract of the pollen, which has been determined to be responsible for the patient's hayfever, is injected.

The required dose of the pollen extract is controlled by the reaction in the diagnostic test, careful records of which are kept for each patient. When the reaction has been marked, smaller doses are used, while in other cases this is increased proportionately.

Should an acute attack again develop, the bacterial vaccine is substituted for the pollen extract, from one to four injections being made. In many cases, one injection is sufficient to control the symptoms.

In all cases the treatment is discontinued when the pollenometric records show that the atmospheric pollens, responsible for the attack, have disappeared. Before this time, however, the treatment is discontinued when the report of the patient indicates the control of the hayfever. At first the treatments are made at longer intervals before being discontinued.

In spite of many thousands of injections which we have made, there have been no case of infection, nor of severe anaphylactic shock. Tincture of iodine is applied to the skin before and after each injection, except for the diagnostic test, when alcohol is applied first, and iodine after the test has been completed.

HAYFEVER AND ASTHMA DUE TO ANIMAL EMANATIONS AND FOOD.

There is a relatively small percentage of hayfever and asthma cases due to epidermal and food proteins. When the symptoms may develop at any time of the year, without regard to the usual pollen seasons, and especially when the history indicates a causative relation, the skin tests for these proteins should be made.

Hayfever and asthma, due to certain foods, are determined by the cutaneous tests, and the omission of the proteins advised that give a positive reaction.

When the cutaneous tests indicate that the paroxysms are

due to the emanation of horses, avoidance of their proximity is advised. In these days of automobiles, this is usually not difficult. When, however, the occupation of the patient makes this impracticable, immunization with the horse epidermal protein is indicated.

A dilution of 1 to 1,000,000 is used for the initial doses, the first injection being 0.1 cc, the second 0.15 cc, and similarly increasing each dose at intervals of three days, until the full centimeter is injected.

Then a dilution of 1 to 100,000 is used, the first dose being 0.2 cc and again increasing each dose by 0.1 cc at intervals of three days, until the full centimeter is injected. If necessary, the 1 to 10,000 dilution is used in a similar manner.

The results in these cases are similar to those obtained from immunization to the pollen proteins.

RESULTS OF TREATMENT.

From an analysis of the results in our Series C, D and E (1000 cases) we find that there were seasonal cures in 49 per cent of the cases and marked improvement in 40, or satisfactory results in 89 per cent of the total number.

In 4 per cent of the cases, there was little or no perceptible improvement, and 7 per cent discontinued the treatment before the results could be noted. In no case was there any aggravation of the hayfever symptoms from the treatment, or other ill effect.

"Seasonal cure" in these cases indicates that there were no more hayfever symptoms for the remainder of the season. Before the opening of the following hayfever season, these cases are again given the diagnostic test. If this is positive the treatment is repeated. In cases of recent origin one course of treatment is usually sufficient, but in cases of longer standing two or three courses are required. In some of the cases treated during previous season, there was no apparent improvement, but the patients had relief from the hayfever symptoms the following season.

The reason for the difference in the effects of pollen injec-

tions is not clearly established. Cooke, Flood and Coca[1] suggest that if the resulting resistance is due to a gradual saturation or neutralization of an antibody-like substance with the active pollen substance, the union of these two bodies is a much less firm one than that in the more susceptible individuals, and that the active pollen substance is discharged from such a combination and eliminated much more quickly in the former than in the latter.

While the average results in these cases are satisfactory, we believe that the number of seasonal cures will be considerably larger when the advantages of the preventive treatment of hayfever are better understood. In the majority of cases in this series, especially in the hayfever clinic, the treatment was not begun until the hayfever had actually developed, when the effects of pollen therapy are not as effective as the preventive treatment.

[1] The Nature of the Process of Mechanism of the Alleviating Effect of Specific Treatment, Jour. Immunol., February, 1917.

CHAPTER XXV.

HAYFEVER IN CHILDREN.

HAYFEVER is relatively common in children, but the reason that this is not more generally known is that these attacks are usually mistaken for "colds." In view of this, parents should be warned, when the symptoms suggest hayfever, that the child be not exposed to infection from hayfever weeds.

The importance of this is illustrated by the following case: A child, aged six years, had suffered for three weeks with a persistent "cold," complicated by asthmatic attacks at night. The attending physician had given a prescription, and advised an abundance of fresh air.

With this in view, the mother carried the child every day to a suburban park so as to have the "purest" air. Unfortunately, however, the park adjoined a large area of the giant ragweed in a fully developed state of pollination. As the child inhaled the pollen-laden air several hours each day, and the diagnostic test showed marked sensitization to the ragweed, the persistence of the symptoms and the nocturnal asthma could easily be explained.

In our Series C, D and E, of 1000 cases, the records show that 5 per cent of the hayfever cases developed before the age of ten years, and 24 per cent before the age of twenty years.

SENSITIZATION DUE TO DIRECT INHALATION OF WILD FLOWERS.

The initial sensitization to hayfever pollens in children is frequently due to the direct inhalation of certain wild flowers. Common among these is the daisy fleabane (*Erig-*

eron strigosus). While this is not strictly a hayfever plant, as it is fertilized by insects, it produces an abundance of noxious pollen, which will develop hayfever if applied directly to the nostrils. It somewhat resembles the common daisy and is therefore frequently collected by children.

The daisy fleabane is a singularly common weed which grows from 1 to 2 feet in height. The light green leaves are linear and toothless, or nearly so, the lower one being broad at the tip. The little daisy-like flowers are $\frac{1}{2}$ inch in width, and with a large green-yellow disk; occasionally the white rays are lilac-tinged and sometimes they are extremely short or altogether absent. They are common in neglected fields and on roadsides.

The pollen of the fleabane is so active that one application of the flower to the nostril may produce an attack of hayfever lasting three or four days. In one case, in which this was inhaled in order to test the reaction, severe symptoms of hayfever developed in a few minutes, and the constitutional symptoms in an hour. The effects lasted four days, the local effect being limited to the left nostril, to which the pollen was applied. This case resembled a "cold" so perfectly that, had the origin not been known, it would undoubtedly have been so considered.

Another common flower, which is not in the list of hayfever weeds because it is not wind-pollinated, but which may cause hayfever in children by direct inhalation, is the common dandelion (*Leontodon taraxacum*) (Fig. 83). This was naturalized as a weed from Europe, but is now common in fields and waste places generally. Children are attracted by the light yellow flowers which are frequently applied to the nostrils. As the pollen is quite active, it causes hayfever, which is usually mistaken for a "cold" and which, in children, it greatly resembles.

There are may other wild flowers, such as the field daisy (*Chrysanthemum*), black-eye Susan (*Rudbekia*) and others, most of which belong to the *Compositæ* family, which, while also harmless in hayfever from a general standpoint, may develop a sensitization in children from direct application to the nostrils.

These flowers are insect-pollinated, and, as the pollen is not found in the air as in the case of wind-pollinated plants, they do not infest the atmosphere for hayfever subjects. When the flower is applied directly to the nostrils, however, and the pollen inhaled in this way, it may develop an anaphylaxis resulting in a sensitization to other hayfever pollens of the same group. As the ragweeds, the principal cause of hayfever in the United States, also belong to the *Compositæ* group, this sensitization may result in a persistent fall hayfever.

A certain relative immunity to hayfever pollens is undoubtedly inherited, as shown by the fact that 37 per cent of hayfever sufferers have relatives of the first degree who suffered from hayfever.[1] This predisposition, however, may remain indefinitely without developing hayfever, as demonstrated by our clinical records, which show that 76 per cent of hayfever cases do not develop hayfever until the age of twenty to thirty years, 57 per cent until thirty to forty, and 27 per cent above this age.

The development of the initial attack of hayfever is due either to a lowered resistance as, for instance, from a depressing illness, or, which is the usual case, from increased exposure. If this results in an attack of hayfever, it is followed by an anaphylaxis to atmospheric pollens, which previously failed to develop an attack.

The direct application of certain flowers to the nostrils in children, therefore, should not be permitted, especially in families in which the development of hayfever in some of the members indicates a hereditary predisposition to this disease.

ADENOIDS AND TONSILS IN HAYFEVER.

Any condition which impairs the normal respiratory passages in children, lowers their resistance and makes them more susceptible to hayfever. Prominent among these are the "adenoids," which interfere with normal nasal breathing

[1] Scheppegrell: Susceptibility to Hayfever, and its Relation to Heredity, Age and Seasons, United States Public Health Service, July 19, 1918.

both directly, by obstructing the posterior nasal passages, and also by causing congestion of the nasal mucous membrane.

Enlarged tonsils, which are usually associated with adenoids, also tend to make children more susceptible to hayfever. The correction of these defects is indicated not only for the hayfever, but also for their effects on the respiratory passages generally and the ears.

ASTHMA IN CHILDREN.

As in adults, asthma is sometimes the dominant symptom of hayfever in children. In many of these cases, the initial nasal symptoms attract little attention in connection with the more serious asthma, and, in some cases, these may even be entirely absent. Whenever the asthma is marked during the usual hayfever seasons, the reaction to pollen is probable. Even when this is not the case, in view of the fact that sometimes hayfever assumes the perennial form, the little patient should be given the intradermal test with the pollen extract. Five units of the pollen extract to be tested are injected into the skin, and, if this is followed by a reaction, the immunizing treatment is indicated. The percentage of cures and improvements in these differs but little from the results in the uncomplicated form of hayfever.

HYGIENIC MEASURES.

Fresh air and exercise is essential in the treatment of hayfever in children, but weed-infested localities should be avoided.

The diet should be carefully regulated, indigestible food being especially avoided. Foods rich in proteins should be reduced during the hayfever season. In cases complicated with asthma, the diet should be carefully watched, and the principal meal be given near the middle of the day.

TREATMENT.

The treatment of hayfever in children does not differ essentially from that in adults. The diagnostic test is made by injecting into the skin 5 units of the pollen extract representing the pollen to which the patient is exposed, as for instance, timothy pollen extract for the *Gramineæ* group, and ragweed extract for the *Ambrosiaceæ* group. The reaction from the injection determines the nature and degree of the patient's sensitization, and forms the basis of the immunizing treatment.

The dosage of the injection in children is based on the usual ratio for their age. In a child of ten to twelve years, for instance, the initial prophylactic dose is 10 units, which is increased by 5 units for each dose, which is given biweekly until 80 to 100 units per dose is injected. The maximum doses are continued until the usual hayfever season commences, when the doses are reduced to 20 units.

In acute attacks, in which there is evidence of a catarrhal complication, the autogenous, or, when this is not available, the mixed catarrhal vaccine is substituted for the pollen extracts, the proportional doses for the age of the child being also observed. When the acute symptom subsides, the immunizing treatment with the pollen extracts is resumed.

The result of the treatment of these cases has been very encouraging, less than 10 per cent failing to be followed by a cure or marked improvement. Cases complicated with asthma appeared to be benefited equally with the uncomplicated form.

CHAPTER XXVI.

THE SEASONS AND GEOGRAPHICAL DISTRIBUTION OF HAYFEVER.

As hayfever is due to the inhalation of wind-borne pollens, the fecundating element of many plants varying in their geographical distribution and period of bloom, the seasons of hayfever and its character differ greatly in the various states of the Union.

Hayfever in different individuals varies not only in degree, but also in the character of the sensitization. There are, for instance, subjects who are sensitive to the pollen of the ragweed (*Ambrosia*), and not to that of the grasses, and *vice versa*; others who react to the pollen of the wormwoods (*Artemisias*), but not to that of the grasses or ragweeds. Others, again, react in various degrees, to all of these pollens.

As a result of this, the types of hayfever vary in different sections of the United States, according to the distribution of the plants that cause the disease. For a similar reason, the seasons in different sections vary, being dependent upon the flowering season of these plants.

CLASSIFICATION.

As already explained, while hayfever is due to the pollen of hundreds of different (anemophilous) plants, our investigations have shown that biologically most of these may be divided into four groups, viz., *Gramineæ*, *Ambrosiaceaæ*, *Artemisia* and *Chenopodiaceæ*, any member of which or a combination of several may be used for immunizing purposes.[1]

A patient sensitive to the pollen protein of one of the

[1] Scheppegrell: United States Pub. Health Rep., September 24, 1920.

several thousands of grasses, *Gramineæ* for instance, is sensitive in various degrees to the others. This is an important matter, as the grass pollens are the principal cause of spring hayfever in most sections of the United States, and this biological similarity renders the immunizing treatment practicable.

The other most common cause of hayfever is the ragweed, and we have found that the pollen of the common ragweed (*Ambrosia elatior*) is representative not only of all the ragweeds, but also the marsh elders (*Iva*), false ragweed (*Gærtneria*) and cockle burs (*Xanthium*), so that the extract of this may be used for immunizing purposes for this group, *Ambrosiaceæ*.

In addition to these, we have segregated, from a biological standpoint, the *Artemisia* group, representing over thirty species of wormwoods, and the *Chenopodiaceæ* group, including true chenopods (*Chenopodium*), amaranths (*Amaranthus*), Russian thistle (*Salsola pestifer* and *kali*) and the docks (*Rumex crispus, acetocella*), etc. The names of the representative groups are therefore given for each state.

In addition to stating the groups causing hayfever in the different states, the names of the most common plants are given. While a pollen extract representative of the group may be used in most cases, one prepared from the pollen of the plants directly responsible sometimes gives more satisfactory results, and should be used when available. The ragweed, for instance, is also representative of the bush sandbur and bur ragweed (*Gærtneria dumosa* and *acanthicarpa*), but when these are in excess of the ragweeds (*Ambrosias*), as they are in the Dakotas, Nebraska, Wyoming, New Mexico and Arizona, it is advantageous to use the pollen of the *Gærtnerias*.

THE CEREALS IN HAYFEVER.

The cereals, such as wheat, rye, oats and corn, also have hayfever pollens, and should be added as a local cause of hayfever in most of the states. The pollen of corn, however,

is so large (80 microns) that its potential area is very circumscribed. The cereals are included in the *Gramineæ* group.

HAYFEVER SEASONS.

In the following report the hayfever seasons of both spring and fall hayfever for all the states are given. These are based on the report of experienced rhinologists in each state. These seasons vary somewhat with different years, as they are influenced by weather conditions, and the dates given are the average for several years. In the case of "local" causes, the hayfever develops during the pollination of the plants or trees listed.

The hayfever seasons of the subjects also vary, being influenced by the individual degree of sensitization. When this is high, the patient's attack commences as soon as there is in the air a small percentage of the pollen to which he reacts; while a less sensitive patient's attack commences only when the pollen infestation is high, which may be a week or more later. The same principle applies to the ending of the season.

HAYFEVER RESORTS.

There are few localities in the United States absolutely free of hayfever, as the pollen of most of hayfever plants are very buoyant, and will traverse 5 or more miles under favorable wind conditions. The localities in the list reported, however, are relatively free, and will therefore be found useful in determining the nearest locality in which the patient will find relief.

ALABAMA.

Spring Hayfever.—April 15 to July 15.

Principal cause, the grasses (*Gramineæ* group), the most common being the following: Johnson grass (*Holcus halopense*), crab grass (*Syntherisma sanguinalis*), yellow fox-tail (*Chæthocloa lutescens*), barnyard grass (*Echinochloa crusgalli*), goose grass (*Eleusine indica*), water grass (*Paspalum dilatum*) and Bermuda grass (*Capriola dactylon*).

Minor cause, curly dock (*Rumex crispus*) and careless weed (*Amaranthus spinosus*) (*Chenopodiaceæ* group).

Locally, elm (*Ulmus americana* and *alata*), cottonwood (*Populus deltoides*) and oaks (species of *Quercus*).

Fall Hayfever.—August 18 to October 10.

Principal cause, common ragweed (*Ambrosia elatior*), the giant ragweed (*Ambrosia trifida*), rough marsh elder (*Iva ciliata*) and cockle bur (species of *Xanthium*) are less frequent causes. All belong to the *Ambrosiaceæ* group.

Hayfever Resorts.—The towns along Mobile Bay are resorts for people having asthma. The Sand Mountain region of the state, comprising the counties of Etowah, Marshall, Cherokee, Blount, Morgan, Colbert and Marion and also Talladega, Shelby, Clay and Randolph, are comparatively free of asthmatics.

Arizona.

Spring Hayfever.—May 5 to June 5.

Principal cause, the grasses, the most common being the following: Annual fescue (*Festuca octoflora*), six-weeks grass (*Bouteloua aristidoides*), mesa grass (*Bouteloua nothrockii*), annual poverty grass (*Aristida bromoides*), blue grass (*Bouteloua gracilis*), silver-top (*Andropogon saccharoides*) (*Gramineæ* group).

Locally, cottonwood (*Populus macdougali*) and Arizona ash (*Fraxinus attenuata*).

Fall Hayfever.—July 15 to October 1.

Principal cause, the *Gærtnerias*, some of which resemble the ragweeds and some the cockle burs. The most common are *Gærtneria discolor, deltoides, dumosa* (bush sand bur), *eriocentra, ambrosioides, illicifolia* and *cordifolia*.

The ragweeds (*Ambrosias*) are also found, although much less common, the species being *Ambrosia aptera* and *psilostachya*. The species of *Gærtneria* and ragweeds both belong to the *Ambrosiaceæ* group.

The wormwoods are also a common cause of hayfever, the most common being prairie sage (*Artemisia gnaphalodes*), found at altitudes from 3500 to 6000 feet, "Indian worm-

wood" (*Artemisia dracunculoides* and *filifolia*) in southeastern part of the state, and sagebrush (*Artemisia tridentata*) in the northern part (*Artemisia* group).

Hayfever Resorts.—The State Board of Health reports that there are no known hayfever resorts in Arizona.

Arkansas.

Spring Hayfever.—June 10 to July 15.

Principal cause, the grasses (*Gramineæ* group), the following being the most common: Little barley (*Hordeum pulsillum*), blue grass (*Poa pratensis*), orchard (*Dactylis glomerata*), timothy (*Phleum pratensis*), witch grass (*Panicum capillare*), species of brome grass (*Bromus*), red-top (*Agrostis alba*), crab grass (*Syntherisma sanguinalis*).

Minor cause, Jerusalem oak and pigweed (*Chenopodium botrys* and *album*) (*Chenopodiaceæ* group).

Locally, maple (*Acer rubrum*), poplar (*Populus heterophylla*) and black willow (*Salix nigra*).

Fall Hayfever.—August 10 to September 17.

Principal cause, common ragweed (*Ambrosia elatior*), and lance-leaved ragweed (*Ambrosia bidentata*). The giant ragweed (*Ambrosia trifida*) is common in moist localities; all these belong to the *Ambrosiaceæ* group. The tall wormwood (*Artemisia caudata*) is prevalent in dry, stony places (*Artemisia* group).

Minor cause, cockle burs (*Xanthium* species) (*Ambrosiaceæ* group).

Hayfever Resorts.—Eureka Springs, Heber Springs, Sylvan Springs and Winslow, all located in the Ozark Range.

California.

Spring Hayfever.—May 5 to July 5.

Principal cause, the grasses, the most common being rye grass (*Lolium perenne*), salt grass (*Distichlis spicata*), Bermuda grass (*Cynodon dactylon*), broncho grass (*Bromus maximus*), wild oats (*Avena fatua*) and Johnson grass (*Holcus halepensis*).

Minor cause, greasebush (*Hymenochloa salsola*), *Rumex conglomerata*, sheep sorrel (*Rumex acetosella*), lamb's quarters or goosefoot (*Chenopodium album*), tumbleweed (*Amaranthus græcizans*) and salt bushes (species of *Atriplex*) (*Chenopodiaceæ* group).

Fall Hayfever.—July 15 to September 10.

Principal cause, sagebrush (*Artemisia tridentata*), mugwort (*Artemisia heterophylla*) (*Artemisia* group).

Minor cause, poverty weed (*Iva axillaris*), bush sand bur (*Franseria dumosa*), western ragweed (*Ambrosia psilostachya*) and (less common) cockle bur (*Xanthium*) (*Ambrosiaceæ* group).

Hayfever Resorts.—Santa Crus, Del Monte, Santa Barbara and Coronado along the coast, and Lake Tabor and other places among the high Sierras.

Colorado.

Spring Hayfever.—May 10 to July 6.

Principal cause, the grasses (*Gramineæ* group), the most common being short-awned chess (*Bromus brizæformis*), downy-brome grass (*Bromus tectorum*), Colorado bluestem (*Agropyron smithii*), blue grass (*Poa pratensis*), orchard grass (*Dactylis glomerata*), prairie June grass (*Koeleria cristata*), blue grama (*Bouteloua gracilis*), silk grass (*Agrostis hiemalis*), timothy (*Phleum pratense*) and squirrel-tail grass (*Hordeum jubatum*).

Minor cause, chenopods and their allies (species of *Chenopodium*) and the Russian thistle (*Salsola pestifer*) (*Chenopodiaceæ* group).

Locally, the cottonwoods (*Populus sargentii* and *angustifolia*), oaks (*Quercus*) in southern half of the state, and box elder (*Acer negunda*) in the canyons.

Fall Hayfever.—July 20 to September 15.

Principal cause, sagebrush (*Artemisia tridentata*) which covers vast areas almost to the exclusion of other plants. Other sages are collectively common (*Artemisia* group). Also, the common ragweed (*Ambrosia elatior*) and prairie

ragweed (*Iva xanthiifolia*), both of which are common roadside weeds (*Ambrosiaceæ* group).

Hayfever Resorts.—Silver plume and other mountains having an altitude of over 7000 feet.

Connecticut.

Spring Hayfever.—June 1 to July 15.

Principal cause, the grasses (*Gramineæ* group), the most common being witch grass (species of *Panicum*), little bluestem (*Andropogon scoparius*), yellow fox-tail (*Setaria glauca*), barnyard grass (*Echinochloa crus-galli*), crab grass (*Panicum serotinum*), blue grass (*Poa pratensis*) and beard grass (*Paspalum setaceum*).

Locally, poplar (*Populus deltoides*), black walnut (*Juglans nigra*) and the oaks (species of *Quercus*).

Fall Hayfever.—August 17 to October 1.

Principal cause, the common ragweed (*Ambrosia elatior*) (*Ambrosiaceæ* group).

Minor cause, the cockle burs (species of *Xanthium*), marsh elder (*Iva frutescens*) (*Ambrosiaceæ* group).

Hayfever Resorts.—The Litchfield Hills, in the northwestern part of the state, afford relief in a certain class of cases along the coast; and the seaside resorts, especially in the New London district, afford relief to a class of inland cases.

Delaware.

Spring Hayfever.—May 5 to July 10.

Principal causes, the grasses (*Gramineæ* group), the most common being timothy (*Phleum pratense*), wheat (*Triticum æstivum*), yellow fox-tail (*Chætochloa lutescens*), broom sedge (*Andropogon virginicus*), little crab grass (*Panicum serotinum*), blue grass (*Poa pratensis*), orchard grass (*Dactylis glomerata*).

Minor cause, sheep sorrel (*Rumex acetosella*), goosefoot (species of *Chenopodium*) (*Chenopodiaceæ* group).

Locally, elms (*Ulmus americana*), black willow (*Salix nigra*) and red maple (*Acer rubrum*).

Fall Hayfever.—August 13 to September 20.

Principal cause, the common ragweed (*Ambrosia elatior*) (*Ambrosiaceæ* group).

Minor cause, giant ragweed (*Ambrosia trifida*) and the cockle bur (species of *Xanthium*) (*Ambrosiaceæ* group).

Hayfever Resorts.—None reported.

DISTRICT OF COLUMBIA.

Spring Hayfever.—May 20 to July 5.

Principal cause, the grasses (*Gramineæ* group), the most common being timothy (*Phleum pratense*), blue grass (*Poa pratensis*), red-top (*Agrostis palustris*), orchard grass (*Dactylis glomerata*), broom sedge (*Andropogon virginicus*), crab grass (*Syntherisma sanguinalis*), spreading witch grass (*Panicum dichotomiflorum*), chess grass (*Bromus secalinus*).

Minor cause, the docks (*Rumex crispus* and *obtusifolia*) (*Chenopodiaceæ* group).

Locally, the cottonwood (*Populus deltoides*) and the oaks (*Quercus rubra, phellos* and *alba*).

Fall Hayfever.—August 17 to October 3.

Principal cause, the common and giant ragweed (*Ambrosia elatior* and *trifida*) (*Ambrosiaceæ* group), the former being common in alleys, vacant lots and roadsides generally. Occasionally also the wormwoods (*Artemisia caudata, annua* and *vulgaris*) (*Artemisia* group).

FLORIDA.

Spring Hayfever.— May 1 to July 10.

Principal cause, the grasses (*Gramineæ* group), the following being the most common: crab grass (*Syntherisma sanguinalis*), Johnson grass (*Holcus halepense*), yellow foxtail grass (*Chætochloa lutescens*), feather grass (*Leptochloa filiformis*), water grass (*Paspalum dilaum*), marsh grass (*Panicum repens*) and barnyard grass (*Echinochloa crus-galli*).

Minor cause, spiny amaranth (*Amaranthus spinosus*), curly dock (*Rumex crispus*), wormseed (*Chenopodium ambrosioides*) (*Chenopodiaceæ* group).

Locally, black willow (*Salix nigra*), elm (*Ulmus americana*), cottonwood (*Populus deltoides*) and oaks (species of *Quercus*).

Fall Hayfever.—August 18 to October 10.

Principal cause, the common and giant ragweed (*Ambrosia elatior* and *trifida*) (*Ambrosiaceæ* group).

Minor cause, marsh elder (*Iva ciliata*) and cockle burs (species of *Xanthium*) (*Ambrosiaceæ* group).

Hayfever Resorts.—The coast of southern Florida affords partial relief.

Georgia.

Spring Hayfever.—May 10 to July 5.

Principal cause, the grasses (*Gramineæ* group), the most common being Bermuda grass (*Capriola dactylon*), Johnson grass (*Holcus halepensis*), wild barley (*Hordeum pusillum*), annual fescue (*Festuca octoflora*), crab grass (*Syntherisma sanguinalis*), yellow fox-tail (*Chætochloa lutescens*), goose-grass (*Eleusine indica*).

Locally, swamp poplar (*Populus heterophylla*), black willow (*Salix nigra*), red maple (*Acer rubrum*) and oaks (species of *Quercus*).

Fall Hayfever.—August 18 to October 4.

Principal cause, the common and giant ragweed (*Ambrosia elatior* and *trifida*), the latter being more common on bottom lands (*Ambrosiaceæ* group).

Minor cause, marsh elder (*Iva ciliata*) and cockle bur (species of *Xanthium*) (*Ambrosiaceæ* group).

Hayfever Resorts.—Brasstown, Bald Mountain.

Idaho.

Spring Hayfever.—May 5 to June 10.

Principal cause, the grasses (*Gramineæ* group), the most common being Hungarian brome grass (*Bromus inermis*), feather bunch grass (*Stipa viridula*), dogtown grass (*Aristida longiseta*), sleepy grass (*Stipa vaseyi*), false cat grass (*Trisetum spicata*), Colorado bluestem grass (*Agropyron smithii*), bearded wheat grass (*Agropyron caninum*) and other tall wheat grasses.

Fall Hayfever.—August 1 to September 15.

Principal cause, sagebrush (*Artemisia tridentata*), Indian wormwood (*Artemisia dracunculoides*) (*Artemisia* group), poverty weed and prairie ragweed (*Iva axillaris* and *Xanthiifolia*) (*Ambrosiaceæ* group).

Minor cause, bur ragweed (*Gærtneria acanthicarpa*), giant and western ragweed (*Ambrosia trifida* and *psilostachya*) (*Ambrosiaceæ* group), grease weed (*Sarcobatus vermiculatus*), Russian thistle (*Salsola pestifer*) (*Chenopodiaceæ* group).

Hayfever Resorts.—None reported.

Illinois.

Spring Hayfever.—June 10 to July 20.

Principal cause, the grasses, the most common being yellow fox-tail grass (*Chætochloa lutescens*), crab grass (*Syntherisma sanguinalis*), witch grass (*Panicum capillare*), squirrel-tail grass (*Hordeum jubatum*) and love grass (*Eragrostis cilianensis*), also the cereals (*Gramineæ group*).

Minor cause, the amaranths (*Amaranthus retroflexus* and *græcizans*), sheep sorrel and curly dock (*Rumex acetosella* and *crispus*), lamb's quarters (*Chenopodium album*) and saltwart (*Salsola kali*) (*Chenopodiaceæ* group).

Locally, elm (*Ulmus americana*), black willow (*Salix nigra*) and oaks (species of *Quercus*).

Fall Hayfever.—August 15 to September 20.

Principal cause, common ragweed (*Ambrosia elatior*), cockle bur (species of *Xanthium*) (*Ambrosiaceæ* group).

Minor cause, giant ragweed (*Ambrosia trifida*).

Hayfever Resorts.—The State Board of Health reports no location free from hayfever.

Indiana.

Spring Hayfever.—June 5 to July 15.

Principal cause, the grasses (*Gramineæ* group), the following being the most common: blue grass (*Poa pratensis*), timothy (*Phleum pratense*), fox-tail (species of *Chætochloa*), crab grass (*Syntherisma sanguinalis*), witch grass (*Panicum

capillare), stinking grass (species of *Eragrostis*), downy brome grass (*Bromus tectorum*), broom sedge (species of *Andropogon*).

Locally, elm (*Ulmus americana*), black willow (*Salix nigra*), swamp poplar (*Populus heterophylla*) and oaks (species of *Quercus*).

Fall Hayfever.—August 17 to September 25.

Principal cause, the common and giant ragweed (*Ambrosia elatior* and *trifida*) (*Ambrosiaceæ* group). The latter is especially common on railroads' embankments, and grows to a height of 12 to 15 feet along the sandy river bottoms. The green wormwood (*Artemisia biennis*) is also fairly common (*Artemisia* group).

Minor cause, Russian thistle (*Salsola pestifer*) and Jerusalem oak (*Chenopodium botrys*) (*Chenopodiaceæ* group), poverty weed (*Iva axillaris*) (*Ambrosiaceæ* group).

Hayfever Resorts.—The State Board of Health reports that no section is free from hayfever, and hayfever sufferers wishing to secure relief, go to northern Michigan.

Iowa.

Spring Hayfever.—June 2 to July 16.

Principal cause, the grasses (*Gramineæ* group), the most common being spreading witch grass (*Panicum dichotomiflorum*), barnyard grass (*Echinochloa crus-galli*), crab grass (*Syntherisma sanguinalis*), broom sedges (*Andropogon scoparius* and *furcatus*), timothy (*Phleum pratense*), blue grass (*Poa pratensis*) and squirrel-tail (*Hordeum jubatum*).

Minor cause, lamb's quarters (*Chenopodium album*) and Russian thistle (*Salsola pestifer*) (*Chenopodiaceæ* group).

Local cause, maple (*Acer spicatum* and winged elm (*Ulmus alata*).

Fall Hayfever.—August 13 to September 27.

Common cause, the common and giant ragweed (*Ambrosia elatior* and *trifida*), the western ragweed (*Ambrosia psilostachya*) and marsh elder (*Iva xanthiifolia*) being an occasional cause (*Ambrosiaceæ* group). The wormwoods (*Artemisia*

ludoviciana, canadensis, biennis, serrata and *caudata*) are also common (*Artemisia group*).

Hayfever Resorts.—The State Board of Health reports none known in the state.

KANSAS.

Spring Hayfever.—May 16 to July 15.

Principal cause, the grasses (*Gramineæ* group), the most common being as follows: bluegrass (*Poa pratensis*), brome grass (*Bromus* species), yellow fox-tail (*Chætochloa lutescens*), timothy (*Phleum pratense*), squirrel tail (*Hordeum jubatum*), quack grass (*Agropyron repens*) and wild rye (*Elymus glabriflorus*).

Locally, cottonwood (*Populus sargentii*), black willow (*Salix nigra*) and red maple (*Acer rubrum*).

Fall Hayfever.—August 16 to September 28.

Principal cause, the common, giant and western ragweed (*Ambrosia elatior, trifida* and *psilostachya*) (*Ambrosiaceæ* group).

Minor cause, saltweed (*Atriplex argentea* and *hastata*) (*Chenopodiaceæ* group) and cockle bur (species of *Xanthium*) (*Ambrosiaceæ* group).

Hayfever Resorts.—None reported.

KENTUCKY.

Spring Hayfever.—June 1 to July 18.

Principal cause, the grasses, the most common being blue grass (*Poa pratensis*), red-top (*Agrostis palustris*), timothy (*Phleum pratense*), crab grass (*Syntherisma sanguinalis*) and yellow fox-tail (*Chætochloa lutescens*) (*Gramineæ group*).

Minor cause, curly and bitter dock and sheep sorrel (*Rumex crispus, obtusifolius* and *acetosella*), spiny amaranth (*Amaranthus spinosus* and *retroflexus*), lamb's quarters and wormseed (*Chenopodium album* and *ambrosioides*) (*Chenopodiaceæ* group).

Locally, aspen (*Populus tremuloides*), black walnut (*Juglans nigra*) and the oaks (species of *Quercus*).

Fall Hayfever.—August 15 to October 1.

Principal cause, common ragweed (*Ambrosia elatior*), the giant ragweed (*Ambrosia trifida*) being common on low ground, and the lance-leaf ragweed (*Ambrosia bidentata*) being found in western Kentucky (*Ambrosiaceæ* group). The annual wormwood (*Artemisia annua*) is common on ground and vacant lots about the outskirts of cities (*Artemisia* group).

Hayfever Resorts.—None reported.

Louisiana.

Spring Hayfever.—May 7 to July 15.

Principal cause, the grasses, the most common being the following: Johnson grass (*Holcus halepensis*), Bermuda grass (*Capriola dactylon*), yellow fox-tail (*Chætochloa lutescens*), feather grass (*Leptochloa filiformis*), marsh grass (*Panicum repens*), annual blue grass (*Poa annua*), water grass (*Paspalum dilatatum* and *larranagai*) and smut grass (*Sporobolus berteroanus*) (*Gramineæ* group).

Minor cause, curly dock (*Rumex crispus*), spiny amaranth (*Amaranthus spinosus*), lamb's quarters (*Chenopodium album*) (*Chenopodiaceæ* group).

Locally, the oaks (species of *Quercus*), white elm (*Ulmus americana*), swamp poplar (*Populus heterophylla*) and black willow (*Salix nigra*).

Fall Hayfever.—August 10 to October 16.

Principal cause, the common and giant ragweed (*Ambrosia elatior* and *trifida*), the latter being common near the gulf coast.

Minor cause, marsh elder (*Iva ciliata*) and the cockle bur (species of *Xanthium*); all belong to the *Ambrosiaceæ* group.

Hayfever Resorts.—Covington, Abita Springs and Magnolia afford relief in the spring type of hayfever.

Maine.

Spring Hayfever.—June 5 to July 10.

Principal cause, the grasses, the most common being quack grass (*Agropyron repens*), barnyard grass (*Echinochloa*

crus-galli), red-top (*Agrostis palustris*), fescue grass (*Festuca elatior*), timothy (*Phleum pratense*) and blue grass (*Poa pratensis*) (*Gramineæ* group).

Minor cause, the docks (*Rumex crispus* and *obtusifolius*), pigweed (*Amaranthus retroflexus*) and lamb's quarters (*Chenopodium album*) (*Chenopodiaceæ* group).

Locally, the aspens (*Populus grandidentata, tremuloides*, etc.) and the oaks (*Quercus rubra* and *alba*).

Fall Hayfever.—August 17 to September 24.

Principal cause, the common ragweed (*Ambrosia elatior*) (*Ambrosiaceæ* group).

Minor causes, the wormwoods (*Artemisia caudata* and *stelleriana*), being common on the sand of Old Orchard, Scarborough and Cape Elizabeth. *Artemisia biennis* is also becoming more common (*Artemisia* group).

Hayfever Resorts.—Rangeley Lakes and Kineo, located on Moosehead Lake.

Maryland.

Spring Hayfever.—May 15 to July 10.

Principal cause, the grasses, the following being the most common: timothy (*Phleum pratense*), wheat, slough grasses (*Spartina*), wild rice (*Zizania palustris*), broom sedge (*Andropogon virginicus*), green fox-tail (*Chætochloa viridis*), blue grass (*Poa pratensis*), quack grass (*Agropyron repens*) and oats (*Gramineæ* group).

Minor cause, the curly and bitter docks and sheep sorrel (*Rumex crispus, obtusifolius* and *acetosella*), pigweed (*Amaranthus retroflexus*) and lamb's quarters and wormseed (*Chenopodium album* and *ambrosioides*) (*Chenopodiaceæ* group).

Fall Hayfever.—August 16 to October 5.

Principal cause, the common and giant ragweed (*Ambrosia elatior* and *trifida*).

Minor cause, marsh elder (*Iva frutescens*) and cockle burs (species of *Xanthium*) (*Ambrosiaceæ* group).

Hayfever Resorts.—None reported.

Massachusetts.

Spring Hayfever.—July 5 to July 18.

Principal cause, the grasses (*Gramineæ* group), the most common being as follows: witch grass (*Panicum capilare*), little bluestem (*Andropogon scoparium*), green fox-tail (*Chætochloa viridis*), quack grass (*Agropyron repens*), orchard grass (*Dactylis glomerata*), barnyard grass (*Echinochloa crus-galli*) and annual blue grass (*Poa annua*).

Minor cause, pigweed (*Amaranthus hybridus*) and Jerusalem oak (*Chenopodium botrys*) (*Chenopodiaceæ* group).

Locally, black willow (*Salix nigra*), aspen (*Populus tremuloides*) and oaks (species of *Quercus*).

Fall Hayfever.—August 13 to September 25.

Principal cause, common ragweed (*Ambrosia elatior*) (*Ambrosiaceæ* group).

Minor cause, Russian thistle (*Salsola pestifer*) (*Chenopodiaceæ* group) and cockle bur (species of *Xanthium*) (*Ambrosiaceæ* group).

Hayfever Resorts.—Commissioner of Public Health reports no known hayfever resort.

Michigan.

Spring Hayfever.—June 8 to July 15.

Principal cause, the grasses (*Gramineæ* group), the most common being as follows: bull grass (*Tripsacum dactyloides*), broom beard-grass (*Schizachyrium scoparium*), forked beard-grass (*Andropogon furcatus*), Indian grass (*Sorghastrum nutans*), prairie grass (*Sporobolus cryptandrus*), Canada blue grass (*Poa compressa*), barnyard grass (*Echinochloa crus-galli*), witch grass (*Panicum capillare*).

Minor cause, water-hemp (*Acnida tamariscina*), pigweed (*Amaranthus retroflexus*) and lamb's quarters (*Chenopodium album*) (*Chenopodiaceæ* group).

Locally, aspens (*Populus grandidentata* and *tremuloides*), white elm (*Ulmus americana*), red maple (*Acer rubrum*) and oaks (*Quercus rubra, alba* and *coccinea*).

Fall Hayfever.—August 15 to September 25.

Principal cause, common ragweed (*Ambrosia elatior*).

Minor cause, cockle bur (species of *Xanthium*) (*Ambrosiaceæ* group), and green wormwood (*Artemisia biennis*) (*Artemisia* group).

Hayfever Resorts.—The northern part of Michigan is relatively free from hayfever.

Minnesota.

Spring Hayfever.—June 25 to July 19.

Principal cause, the grasses (*Gramineæ* group), the most common being as follows: Timothy (*Poa pratensis*), blue-joint grass (*Calamagrostis canadensis*), wild rye (*Elymus canadensis*), red-top (*Agrostis alba*), crested hair grass (*Koeleria cristata*), bunch grass (*Stipa spartea*), forked beard grass (*Andropogon furcatus*).

Minor cause, saltweed (*Atriplex argentea*) (*Chenopodiaceæ* group).

Fall Hayfever.—August 14 to September 26.

Principal cause, common ragweed (*Ambrosia elatior*).

Minor cause, giant ragweed (*Ambrosia trifida*) and western ragweed (*Ambrosia psilostachya*) (*Artemisia* group), Russian thistle (*Salsola pestifer*) (*Chenopodiaceæ* group) and wormwoods (*Artemisia ludoviciana, dracunculoides* and *caudata*) (*Artemisia* group).

Hayfever Resorts.—Duluth is favorably reported.

Missouri.

Spring Hayfever.—May 10 to July 26.

Principal cause, the grasses (*Gramineæ* group), the most common being yellow fox-tail (*Chætochloa lutescens*), red-top (*Agrostis palustris*), blue grass (*Poa pratensis*), chess or cheat (*Bromus secalinus*), wild barley (*Hordeum pusillum*), orchard grass (*Dactylis glomerata*), timothy (*Phleum pratense*) and barnyard grass (*Echinochloa crus-galli*).

Minor cause, lamb's quarters (*Chenopodium album*) and saltweed (*Atriplex argentea* and *hastata*) (*Chenopodiaceæ* group).

Locally, red maple (*Acer rubrum*) and black willow (*Salix nigra*).

Fall Hayfever.—August 12 to September 24.

Principal cause, common and giant ragweed (*Ambrosia elatior* and *trifida*).

Minor cause, western and lance-leaf ragweed (*Ambrosia psilostachya* and *bidentata*) (*Ambrosiaceæ* group).

Locally, the wormwoods (*Artemisia biennis* and *caudata*) (*Artemisia* group).

Hayfever Resorts.—None reported by the State Board of Health.

MISSISSIPPI.

Spring Hayfever.—May 10 to July 10.

Principal cause, the grasses (*Gramineæ* group), the most common being smut grass (*Sporabolus berteroanus*), Bermuda grass (*Capriola dactylon*), yellow fox-tail (*Chætochloa lutescens*), crab grass (*Syntherisma sanguinalis*), barnyard grass (*Echinochloa crus-galli*), marsh grass (*Panicum repens*) and water grass (*Paspalum dilatatum*).

Minor cause, curly dock (*Rumex crispus*), spiny amaranth *amaranthus spinosus*), English plantain (*Plantago lanceolata*), and lamb's quarters (*Chenopodium album*) (*Chenopodiaceæ* group)

Locally, elm (*Ulmus americana*), swamp poplar (*Populus heterophylla*), black willow (*Salix nigra*) and oaks (species of *Quercus*).

Fall Hayfever.—August 18 to October 25.

Principal cause, common and giant ragweed (*Ambrosia elatior* and *trifida*).

Minor cause, cockle bur (species of *Xanthium*) and marsh elder (*Iva ciliata*) (*Ambrosiaceæ* group).

Hayfever Resorts.—None reported.

MONTANA.

Spring Hayfever.—May 15 to July 15.

Principal cause, the grasses (*Gramineæ* group), the most common being as follows: wheat grass (*Agropyron dasystachyum*), blue grama (*Bouteloua gracilis*), Colorado blue-

stem (*Agropyron smithii*), alkali bunch grass (*Sporobolus airoides*), Hungarian brome grass (*Bromus inermis*), feather bunch grass (*Stipa viridula*) and crab grass (*Syntherisma linearis*).

Fall Hayfever.—August 5 to September 15.

Principal cause, common and giant ragweed (*Ambrosia elatior* and *trifida*) (*Ambrosiaceæ* group), and common sagebrush (*Artemisia tridentata*), carpet sage (*Artemisia frigida*) and prairie wormwood (*Artemisia ludoviciana*) (*Artemisia* group).

Hayfever Resorts.—None reported.

Nebraska.

Spring Hayfever.—May 15 to July 15.

Principal cause, the grasses (*Gramineæ* group), the most common being as follows: Downy brome grass (*Bromus tectorum*), blue grass (*Poa pratensis*), Colorado blue-stem (*Agropyron smithii*), quack grass (*Agropyron repens*), timothy (*Phleum pratense*) and squirrel-tail (*Hordeum jubatum*).

Locally, cottonwoods (*Populus sargentii* and *angustifolia.*)

Minor cause, greasewood (*Sarcobatus vermiculatus*) (*Chenopodiaceæ* group).

Fall Hayfever.—August 8 to September 18.

Principal cause, in the eastern section of the state the common and giant ragweed (*Ambrosia elatior* and *trifida*) (*Ambrosiaceæ* group), in the western section the Indian wormwood (*Artemisia dracunculoides*), prairie sage (*Artemisia gnaphalodes*) and Canada wormwood (*Artemisia canadensis*) (*Artemisia* group).

Minor causes, the species of *Franseria discolor, tomentosa* and *acanthicarpa*) (*Ambrosiaceæ* group).

Hayfever Resorts.—The high, elevated areas of the western part of the state are of benefit to hayfever sufferers.

Nevada.

Spring Hayfever.—May 1 to July 15.

Principal cause, the grasses (*Gramineæ* group), the most common being as follows: Hungarian brome grass (*Bromus

inermis), feather bunch grass (*Stipa viridula*), dogtown grass (*Aristida longiseta*), sleepy grass (*Stipa vaseyi*), false oat grass (*Trisetum spicatum*), Colorado blue-stem (*Agropyron smithii*), bearded wheat grass (*Agropyron caninum*).

Minor causes, greasewood (*Sarcobatus vermiculatus*) (*Chenopodiaceæ* group).

Fall Hayfever.—August 12 to September 15.

Principal cause, Indian wormwood (*Artemisia dracunculoides*), California mugwort (*Artemisia heterophylla*) and sagebrush (*Artemisia tridentata*) (*Artemisia* group).

Minor cause, poverty weed (*Iva axillaris*), prairie ragweed (*Iva xanthiifolia*), bush sand bur (*Franseria dumosa*) and bur ragweed (*Franseria acanthicarpa*) (*Ambrosiaceæ* group).

Hayfever Resorts.—None reported.

New Hampshire.

Spring Hayfever.—June 10 to July 16.

Principal cause, the grasses (*Gramineæ* group), the most common being as follows: witch grass (*Panicum* species), red-top (*Agrostis palustris*), timothy (*Phleum pratense*), quack grass (*Agropyron repens*), little blue-stem (*Andropogon scoparius*), green fox-tail (*Setaria viridis*) and annual bluegrass (*Poa annua*).

Minor cause, lamb's quarters (*Chenopodium album*), sheep sorrel (*Rumex acetosella*) and saltweed (*Atriplex hastata*) (*Chenopodiaceæ* group).

Fall Hayfever.—August 16 to October 1.

Principal cause, common ragweed (*Ambrosia elatior*).

Minor cause, giant ragweed (*Ambrosia trifida*) and cockle bur (*Xanthium* species) (*Ambrosiaceæ* group), elm (*Ulmus americana*) and oaks (species of *Quercus*).

Hayfever Resorts.—None reported.

New Jersey.

Spring Hayfever.—June 10 to July 24.

Principal cause, the grasses (*Gramineæ* group), the most common being as follows: Little blue-stem (*Andropogon sco-*

parius), beard grass (*Paspalum setaceum*), witch grass (*Panicum capillare* and *dichotomiflorum*), barnyard grass (*Echinochloa crus-galli*), yellow fox-tail (*Chætochloa lutescens*), nimble Will (*Muhlenbergia schreberi*), purple-top (*Tridens flavus*).

Minor cause, curly dock and sheep sorrel (*Rumex crispus* and *acetosella*), lamb's quarters (*Chenopodium album*), pigweed (*Amaranthus retroflexus*) and English plantain (*Plantago lanceolata*) (*Chenopodiaceæ* group).

Locally, aspen (*Populus tremuloides*), black willow (*Salix nigra*) and oaks (species of *Quercus*).

Fall Hayfever.—August 17 to September 28.

Principal cause, common and giant ragweeds (*Ambrosia elatior* and *trifida*) and cockle-bur (species of *Xanthium*) (*Ambrosiaceæ* group).

Minor cause, Russian thistle (*Salsola pestifer*) (*Chenopodiaceæ* group).

Hayfever Resorts.—Partial relief at locations along the Atlantic coast and Beach Haven in Ocean County.

New Mexico.

Spring Hayfever.—May 3 to June 5.

Principal cause, the grasses (*Gramineæ* group), the most common being Hungarian brome grass (*Bromus inermis*), feather bunch grass (*Stipa viridula*), dogtown grass (*Aristida longiseta*), sleepy grass (*Stipa vaseyi*), false oat grass (*Trisetum spicatum*), Colorado bluestem (*Agropyron smithii*), bearded wheat grass (*Agropyron caninum*).

Minor cause, greasewood (*Sarcobatus vermiculatus*) (*Chenopodiaceæ* group).

Locally, cottonwood (*Populus wislizeni*).

Fall Hayfever.—July 12 to September 28.

Principal cause, sagebrush (*Artemisia tridentata*), carpet sage (*Artemisia frigida*) and other wormwoods (*Artemisia* group).

Minor cause, poverty weed (*Iva axillaris*), bur ragweed (*Franseria acanthicarpa* and *tenuifolia*) (*Ambrosiaceæ* group).

Hayfever Resorts.—Cloudcroft, Whitcom Springs, El Por-

venir, Albuquerque, Jemez Springs, Sulphur Springs, Valley Rancho, Glorietta and East Las Vegas.

New York.

Spring Hayfever.—June 5 to July 19.

Principal cause, the grasses (*Gramineæ* group), the most common being as follows: Little bluestem (*Andropogon acoparius*), witch or panic grass (*Panicum*), barnyard grass (*Echinochloa crus-galli*), fox-tail (*Chætochloa glauca* and *viridis*), reed canary grass (*Phalaris arundinacea*), quack grass (*Agropyron repens*), dropseed grass (*Muhlenbergia*), red-top (*Agrostis palustris*), blue-joint (*Calamagrostis canadensis*), wild oat-grass (*Danthonia spicata*), love grass (*Eragrostis*), orchard grass (*Dactylis glomerata*), annual blue grass (*Poa annua*), manna grass (*Panicularia nervata*).

Minor cause, curly dock (*Rumex crispus*), pigweed (*Amaranthus retroflexus* and *hybridus*), Jerusalem oak and lamb's quarters (*Chenopodium botrys* and *album*) (*Chenopodiaceæ* group).

Fall Hayfever.—August 16 to September 28.

Principal cause, common and giant ragweed (*Ambrosia elatior* and *trifida*).

Minor cause, cockle bur (species of *Xanthium*) (*Ambrosiaceæ* group), Russian thistle (*Salsola pestifer*) (*Chenopodiaceæ* group).

Locally, the wormwoods, the most common being *Artemisia biennis* and *stelleriana* (*Artemisia* group).

Hayfever Resorts.—The Adirondacks, Fire Island, Thousand Islands Park, Big Moose and Old Forge Lake.

North Carolina.

Spring Hayfever.—May 13 to June 20.

Principal cause, the grasses (*Gramineæ* group), the most common being blue grass (*Poa pratensis*), orchard grass (*Dactylis glomerata*), timothy (*Phleum pratense*), red-top (*Agrostis palustris*), Bermuda grass (*Capriola dactylon*), crab

grass (*Syntherisma sanguinalis*), crowfoot grass (*Dactyloctenium ægyptium*) and witch grass (*Panicum capillare*).

Locally, elm (*Ulmus americana*), cottonwood (*Populus deltoides*), black willow (*Salix nigra*) and oaks (species of *Quercus*).

Fall Hayfever.—August 20 to October 5.

Principal cause, the common and giant ragweeds (*Ambrosia elatior* and *trifida*), the latter being uncommon in the northwest (mountain) section (*Ambrosiaceæ* group).

Minor cause, cockle bur (species of *Xanthium*) and marsh elder (*Iva ciliata*) (*Ambrosiaceæ* group).

Hayfever Resorts.—Eagle's Nest, Glen Ayre, Blackstock Knob, Black Dome, Mount Gibbs, Hall Back and Mount Mitchell in the Black Mountains; Double Springs, Richland Balsam and Jones Knob in the Balsam Range; Mount Buckley, Clingman's Drive, Mount Love and Alexander in the Smoky Mountains.

North Dakota.

Spring Hayfever.—May 20 to July 15.

Principal cause, the grasses (*Gramineæ* group), the most common being as follows: quack grass (*Agropyron repens*), squirrel tail (*Hordeum jubatum*), millet (*Chætochloa italica*), Hungarian brome grass (*Bromus inermis*), Colorado bluestem (*Agropyron smithii*), wild oats (*Avena fatua*), barnyard grass (*Echinochloa crus-galli*), green fox-tail (*Chætochloa viridis*), blue grass (*Poa pratensis* and *flava*).

Minor cause, white dock (*Rumex mexicanus*), pigweed (*Amaranthus retroflexus*) and lamb's quarters (*Chenopodium album*) (*Chenopodiaceæ* group).

Locally, Sargent's cottonwood (*Populus sargentii*).

Fall Hayfever.—August 10 to September 15.

Principal cause, common, giant and western ragweed (*Ambrosia elatior, trifida* and *psilostachya*) (*Ambrosiaceæ* group), carpet sage (*Artemisia frigida*), prairie wormwood (*Artemisia ludoviciana*) and green wormwood (*Artemisia biennis*) (*Artemisia* group).

Hayfever Resorts.—The State Board of Health reports hayfever patients benefited at Devil's Lake.

OHIO.

Spring Hayfever.—May 28 to July 13.

Principal cause, the grasses (*Gramineæ* group), the most common being crab grass (*Syntherisma sanguinalis*), witch grass (*Panicum capillare*), spreading witch grass (*Panicum dichotomiflorum*), barnyard grass (*Echinochloa crus-galli*), green fox-tail (*Chætochloa viridis*), love grass (*Eragrostis cilianensis*).

Minor cause, pigweed (*Amaranthus hybridus* and *retroflexus*) and water-hemp (*Acnida tuberculata*).

Locally, black willow (*Salix nigra*) and swamp poplar (*Populus heterophylla*).

Fall Hayfever.—August 13 to September 20.

Principal cause, common and giant ragweed (horseweed) (*Ambrosia elatior* and *trifida*) (*Ambrosiaceæ* group).

Minor cause, the southernwood (*Artemisia abrotanum*) and common wormwood (*Artemisia vulgaris*) (*Artemisia* group), Russian thistle (*Salsola pestifer*) and Jerusalem oak and lamb's quarters (*Chenopodium botrys* and *album*) (*Chenopodiaceæ* group).

Hayfever Resorts.—The State Board of Health reports no hayfever resorts known in state.

OKLAHOMA.

Spring Hayfever.—May 10 to June 24.

Common cause, the grasses (*Gramineæ* group), the most common being chess (*Bromus secalinus*), yellow fox-tail (*Chætochloa lutescens*), red-top (*Agrostis palustris*), crab grass (*Chætochloa glauca*), feather bunch grass (*Stipa viridula*) and needle-and-thread grass (*Stipa comata*).

Minor cause, saltweed (*Atriplex hastata*) (*Chenopodiaceæ* group).

Fall Hayfever.—July 25 to October 1.

Principal cause, the giant and common ragweeds (*Ambrosia trifida* and *elatior*), the latter being less common (*Ambrosiaceæ* group); and the prairie wormwood (*Artemisia ludoviciana*) (*Artemisia* group).

Minor cause, the cockle bur (species of *Xanthium*) (*Ambrosiaceæ* group).

Hayfever Resorts.—The State Board of Health reports that, while hayfever is less common in Oklahoma than in most sections of the country, there is no locality that is absolutely free from this disease.

Oregon.

Spring Hayfever.—April 25 to May 29.

Principal cause, the grasses (*Gramineæ* group), velvet grass (*Notholcus lanatus*) is the most common in western Oregon. Others are sweet vernal grass (*Anthoxanthum odoratum*), western brome grass (*Bromus carinatus*), orchard grass (*Dactylis glomerata*), rye grass (*Lolium perenne*) and blue grass (*Poa pratensis*).

Minor cause, the docks (*Rumex crispus* and *occidentalis*), lamb's quarters and red blite (*Chenopodium album* and *rubrum*) (*Chenopodiaceæ* group).

Fall Hayfever.—July 1 to September 10.

Principal cause, sagebrush (*Artemisia tridentata*), prairie wormwood (*Artemisia ludoviciana*).

Minor cause, carpet sage (*Artemisia frigida*) and Indian wormwood (*Artemisia dracunculoides*) (*Artemisia* group), poverty weed (*Iva axillaris*), prairie ragweed (*Iva xanthiifolia*), and bur ragweed (*Franseria acanthicarpa*) (*Ambrosiaceæ* group.

Hayfever Resorts.—None reported.

Pennsylvania.

Spring Hayfever.—June 3 to July 24.

Principal cause, the grasses (*Gramineæ* group), the following being the most common: Timothy (*Phleum pratense*), red-top (*Agrostis palustris*), blue grass (*Poa pratensis*), quack grass (*Agropyron repens*), orchard grass (*Dactylis glomerata*), witch grass (*Panicum capillare*), yellow fox-tail (*Chætochloa lutescens.*)

Locally, elms (*Ulmus americana* and *alata*) and oaks (species of *Quercus*).

Fall Hayfever.—August 16 to September 27.

Principal cause, the common and giant ragweed (*Ambrosia elatior* and *trifida*), the latter occurring in great thickets along the flood plains of the rivers, and even on the slopes and upland in great numbers (*Ambrosiaceæ* group).

Minor cause, Russian thistle (*Salsola pestifer*) and Jerusalem oak and lamb's quarters (*Chenopodium botrys* and *album*) (*Chenopodiaceæ* group).

Hayfever Resorts.—Eaglesmere, the Pocono Mountains, the hills in the vicinity of Bradford and the mountains near Mount Alto and Caledonia.

Rhode Island.

Spring Hayfever.—June 8 to July 22.

Principal cause, the grasses (*Gramineæ* group), the most common being as follows: red-top (*Agrostis palustris*), timothy (*Phleum pratense*), orchard grass (*Dactylis glomerata*), blue grass (*Poa pratensis*). The most common grasses in old fields are sweet vernal grass (*Anthoxanthum odoratum*).

Locally, aspen (*Populus tremuloides*), black willow (*Salix nigra*) and oaks (species of *Quercus*).

Fall Hayfever.—August 15 to September 26.

Principal cause, the common ragweed (*Ambrosia elatior*) (*Ambrosiaceæ* group).

Minor cause, giant ragweed (*Ambrosia trifida*), marsh elder (*Iva ciliata*) and cockle burs (species of *Xanthium*) (*Ambrosiaceæ* group).

Hayfever Resorts.—The State Board of Health reports that, while hayfever is not very prevalent, there is no part of Rhode Island free from hayfever.

South Carolina.

Spring Hayfever.—May 10 to July 6.

Principal cause, the grasses (*Gramineæ* group), the following being the most common: crab grass (*Syntherisma sangui-*

nalis), Johnson grass (*Holcus halepensis*), yellow fox-tail (*Chætochloa lutescens*), Bermuda grass (*Capriola dactylon*), red-top (*Agrostis palustris*), goose-grass (*Eleusine indica*) and water-grass (*Paspalum dilatatum*).

Minor cause, lamb's quarters (*Chenopodium album*), curly dock (*Rumex crispus*), spiny amaranth (*Amaranthus spinosus*) and plantain (*Plantago major*) (*Chenopodiaceæ* group).

Locally, elm (*Ulmus americana*), red maple (*Acer rubrum*), swamp poplar (*Populus heterophylla*) and oaks (species of *Quercus*).

Fall Hayfever.—August 18 to October 10.

Principal cause, the common and giant ragweed (*Ambrosia elatior* and *trifida*) (*Ambrosiaceæ* group).

Minor cause, cockle burs (species of *Xanthium*), horse-weed (*Erigeron canadensis*) and marsh elder (*Iva imbricata*) (*Ambrosiaceæ* group).

Hayfever Resorts.—Cæsar's Head, Greenville County.

South Dakota.

Spring Hayfever.—May 13 to July 10.

Common cause, the grasses (*Gramineæ* group), the most common being blue grama (*Bouteloua gracilis*), wheat grass (*Agropyron dasystachyum*), green fox-tail (*Chætochloa viridis*), squirrel-tail (*Hordeum jubatum*), crab grass (*Syntherisma linearis*), blue grass (*Poa pratensis*), blue-joint (*Andropogon furcatus*) and porcupine grass (*Stipa spartea*).

Locally, narrow-leaf cottonwood (*Populus angustifolia*).

Fall Hayfever.—August 8 to September 22.

Principal cause, prairie wormwood (*Artemisia ludoviciana*), green wormwood (*Artemisia biennis*) and Canada wormwood (*Artemisia canadensis* (*Artemisia* group). These are more common in the country. In the cities the principal causes are the common and giant ragweed (*Ambrosia elatior* and *trifida*) (*Ambrosiaceæ* group).

Minor cause, Russian thistle (*Salsola pestifer*) (*Chenopodiaceæ* group).

Hayfever Resorts.—Hot Springs.

TENNESSEE.

Spring Hayfever.—June 5 to July 22.

Principal cause, the grasses (*Gramineæ* group), the most common being as follows: Crab grass (*Syntherisma sanguinalis*), broom sedge (*Andropogon virginicus*), red-top (*Agrostis palustris*), barnyard grass (*Echinochloa crus-galli*), yellow fox-tail (*Chætochloa lutescens*), goose grass (*Eleusine indica*), purple-top (*Tridens flavus*), blue grass (*Poa pratensis*).

Locally, elms (*Ulmus americana* and *alata*), cottonwood (*Populus deltoides*) and oaks (species of *Quercus*).

Fall Hayfever.—August 15 to October 5.

Principal cause, the common and giant ragweed (*Ambrosia elatior* and *trifida*) (*Ambrosiaceæ* group). The annual wormwood (*Artemisia annua*) is common in the middle and western sections of the state (*Artemisia* group).

Minor cause, cockle bur (species of *Xanthium*) (*Ambrosiaceæ* group).

Hayfever Resorts.—Roan Mountain (altitude 6310 feet) has long been noted for its relief to hayfever sufferers.

TEXAS.

Spring Hayfever.—May 15 to July 15.

Principal cause, the grasses (*Gramineæ* group), the most common being the following: Yellow fox-tail (*Chætochloa lutescens*), Johnson grass (*Holcus halepensis*), Bermuda grass (*Capriola dactylon*), water-grass (*Paspalum larranagai*), smut grass (*Sporobolus berteroanus*), brome grass (*Bromus inermis*) and feather bunch grass (*Stipa viridula*).

Minor cause, Jerusalem oak and lamb's quarters (*Chenopodium botrys* and *album*) (*Chenopodiaceæ* group).

Locally, elm (*Ulmus americana*), narrow-leaf cottonwood (*Populus angustifolia*), oaks (species of *Quercus*) and mountain cedar (*Juniperus sabinoides*), (Northwestern section).

Fall Hayfever.—August 18 to October 15.

Principal cause, in the eastern section, the giant, common and western ragweed (*Ambrosia trifida, elatior* and *psilostachya*) (*Ambrosiaceæ* group). In the western portion of the

state the ragweeds are replaced by the wormwoods, the most common being Indian wormwood (*Artemisia dracunculoides*), carpet sage (*Artemisia frigida*) and prairie wormwood (*Artemisia ludoviciana*) (*Artemisia* group).

Minor cause, bur ragweed (*Franseria acanthicarpa*), horseweed (*Erigeron canadensis*) and marsh elder (*Iva ciliate*) (*Ambrosiaceæ* group).

Hayfever Resorts.—None reported.

Utah.

Spring Hayfever.—June 22 to July 27.

Principal cause, the grasses (*Gramineæ* group), the most common being Hungarian brome grass (*Bromus inermis*), feather bunch grass (*Stipa viridula*), dogtown grass (*Aristida longiseta*), sleepy grass (*Stipa vaseyi*), false oat grass (*Trisetum spicatum*), Colorado blue-stem (*Agropyron smithii*), bearded wheat grass (*Agropyron caninum*).

Minor cause, greasewood (*Sarcobatus vermiculatus*), saltweed (*Atriplex argentea* and *hastata*) (*Chenopodiaceæ* group), bush sand bur (*Franseria dumosa*) (*Ambrosiaceæ* group).

Fall Hayfever.—August 5 to September 15.

Principal cause, common ragweed (*Ambrosia elatior*) (*Ambrosiaceæ* group) and sagebrush and prairie sage (*Artemisia tridentata* and *gnaphalodes*) (*Artemisia* group).

Minor cause, giant ragweed (*Ambrosia trifida*) and poverty weed (*Iva axillaris*) (*Ambrosiaceæ* group).

Hayfever Resorts.—There are a number of places in various parts of this state, having an altitude of over 6000 feet, which afford relief to hayfever subjects; also several canyon resorts, such as Brighton and Ogden, where comparative freedom from hayfever exists. Many persons from Salt Lake City, which has an elevation of 4300 feet, visit these places and obtain relief.

Vermont.

Spring Hayfever.—June 10 to July 22.

Principal cause, the grasses (*Gramineæ* group), the following being the most common: Yellow fox-tail (*Chætochloa*

lutescens), barnyard grass (*Echinochloa crus-galli*), red-top (*Agrostis palustris*), little blue stem (*Andropogon scoparius*), timothy (*Phleum pratense*), spreading witch grass (*Panicum dichotomiflorum*) and crab grass (*Syntherisma sanguinalis*).

Minor cause, sheep sorrel (*Rumex acetosella*), lamb's quarters and goosefoot (species of *Chenopodium*) (*Chenopodiaceæ* group).

Locally, red maple (*Acer rubrum*) and oaks (species of *Quercus*).

Fall Hayfever.—August 14 to September 24.

Principal cause, the common ragweed (*Ambrosia elatior*) (*Ambrosiaceæ* group).

Minor cause, giant ragweed (*Ambrosia trifida*), cockle bur (species of *Xanthium*) (*Ambrosiaceæ* group), Russian thistle (*Salsola pestifer*) (*Chenopodiaceæ* group).

Hayfever Resorts.—Green Mountains (4430 feet).

VIRGINIA.

Spring Hayfever.—May 15 to June 29.

Principal cause, the grasses (*Gramineæ* group), the most common being Kentucky blue grass (*Poa pratensis*), timothy (*Phleum pratense*), red-top (*Agrostis vulgaris*), orchard grass (*Dactylis glomerata*), tall oat grass (*Arrhenatherum elatius*), Canada blue grass (*Poa compressa*), meadow fescue (*Festuca elatior*), rye grass (*Lolium perenne*).

Minor cause, sheep sorrel (*Rumex acetocella*), worm seed (*Chenopodium ambrosioides*) and horseweed (*Erigeron canadensis*).

Locally, black willow (*Salix nigra*), black walnut (*Juglans nigra*), red maple (*Acer rubrum*) and oaks (species of *Quercus*).

Fall Hayfever.—August 18 to October 3.

Principal cause, common ragweed (*Ambrosia elatior*).

Minor cause, giant ragweed (*Ambrosia trifida*) and marsh elder (*Iva ciliata*) (*Ambrosiaceæ* group).

Hayfever Resorts.—None reported.

WASHINGTON.

Spring Hayfever.—June 12 to July 1.

Principal cause, the grasses (*Gramineæ* group), the most common being timothy (*Phleum pratense*), blue grass (*Poa pratensis*), red-top (*Agrostis alba*), orchard grass (*Dactylis glomerata*), broom sedge (*Andropogon virginicus*), crab grass (*Syntherisma sanguinalis*), witch grass (*Panicum dichotomiflorum*), chess grass (*Bromus secalinus*).

Fall Hayfever.—July 5 to October 7.

Principal cause, the bur ragweed (*Gaertneria chamissomis* and *bipinnatifida*) (east of Cascade Mountains), poverty weed and prairie ragweed (*Iva axillaris* and *xanthiifolia*) and giant, common and western ragweed (*Ambrosia trifida, elatior* and *psilostachya*) (*Ambrosiaceæ* group).

Minor cause, Jerusalem oak (*Chenopodium botrys*) and Russian thistle (*Salsola pestifer*) (*Chenopodiaceæ* group).

Hayfever Resorts.—Although there is the usual percentage of hayfever east of the Cascade Mountain Range, there is little in any part of the state west of this range, which is, therefore, favorable to hayfever subjects.

WEST VIRGINIA.

Spring Hayfever.—May 15 to June 29.

Principal cause, the grasses (*Gramineæ* group), the most common being as follows: Spreading witch grass (*Panicum dichotomiflorum*), crab grass (*Syntherisma sanguinalis*), green fox-tail (*Chætochloa viridis*), love grass (*Eragrotis cilianensis*), blue grass (*Poa pratensis*), chess (*Bromus secalinus*) and timothy (*Phleum pratense*).

Minor cause, curly dock (*Rumex crispus*), Jerusalem oak (*Chenopodium botrys*) and pigweed (*Amaranthus retroflexus*) (*Chenopodiaceæ* group).

Locally, red maple (*Acer rubrum*), swamp poplar (*Populus heterophylla*), black willow (*Salix nigra*) and oak (species of *Quercus*).

Fall Hayfever.—August 12 to September 28.

Principal cause, common ragweed (*Ambrosia elatior*).

Minor cause, giant ragweed (*Ambrosia trifida*), the cockle bur (species of *Xanthium*) (*Ambrosiaceæ* group).

Hayfever Resorts.—Terra Alta, Marlinton and Webster Springs are favorably reported, although their altitude (2500 feet) is not sufficient to afford marked relief.

WISCONSIN.

Spring Hayfever.—June 7 to July 18.

Principal cause, the grasses (*Gramineæ* group), the most common being as follows: Oats, blue grass (*Poa pratensis*), timothy (*Phleum pratense*), red-top (*Agrostis palustris*) and quack grass (*Agropyron repens*).

Minor cause, the curly dock (*Rumex crispus*) and lamb's quarters (*Chenopodium album*) (*Chenopodiaceæ* group).

Locally, aspen (*Populus tremuloides*) and the oaks (*Quercus alba, velutina, rubra* and *macrocarpa*).

Fall Hayfever.—August 17 to September 28.

Principal cause, common ragweed (*Ambrosia elatior*).

Minor cause, giant ragweed (*Ambrosia trifida*) and prairie ragweed (*Iva xanthiifolia*) in western part (*Ambrosiaceæ* group), green wormwood (*Artemisia biennis*) (*Artemisia* group), Russian thistle (*Salsola pestifer*) (*Chenopodiaceæ* group).

Hayfever Resorts.—Two Rivers, located on a peninsula extending seven miles into Lake Michigan.

WYOMING.

Spring Hayfever.—May 1 to June 15.

Principal cause, the grasses (*Gramineæ* group), the most common being as follows: Colorado blue-stem (*Agropyron smithii*), alkali, bunch grass (*Sporobolus airoides*), blue grass (*Poa pratensis*), timothy (*Phleum pratense*), prairie June grass (*Kœleria cristata*), squirrel-tail (*Hordeum jubatum*), tall manna grass (*Panicularia grandis*), fescue grass (*Festuca elatior*), western wild rye (*Elymus condensatus*) and tufted hair grass (*Deschampsia cæspitosa*).

Fall Hayfever.—August 5 to September 15.

Principal cause, prairie ragweed (*Iva xanthiifolia*) (*Ambrosiaceæ* group) and sagebrush (*Artemisia tridentata*) (*Artemisia* group).

Minor cause, giant and western ragweed (*Ambrosia trifida* and *psilostachya*) (*Ambrosiaceæ group*), northern and aromatic wormwood (*Artemisia borealis* and *aromatica*) and the prairie sage (*Artemisia gnaphalodes*) (*Artemisia* group), greasewood (*Sarcobatus vermiculatus*) and Russian thistle (*Salsola pestifer*) (*Chenopodiaceæ* group).

Hayfever Resorts.—The State Board of Health reports that there is no locality free from hayfever.

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Scheppegrell, W.
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NAME	DATE DUE
Dr. R. R. Montgomery Long Beach	JUN 19 1941